OFFICIAL PUBLICATION OF THE PROCEEDINGS AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

VOLUME 44, NO. 16
AUGUST 1, 1955

AMERICAN DYESTUFF REPORTER

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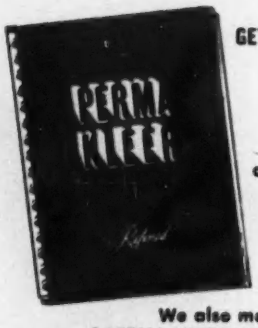

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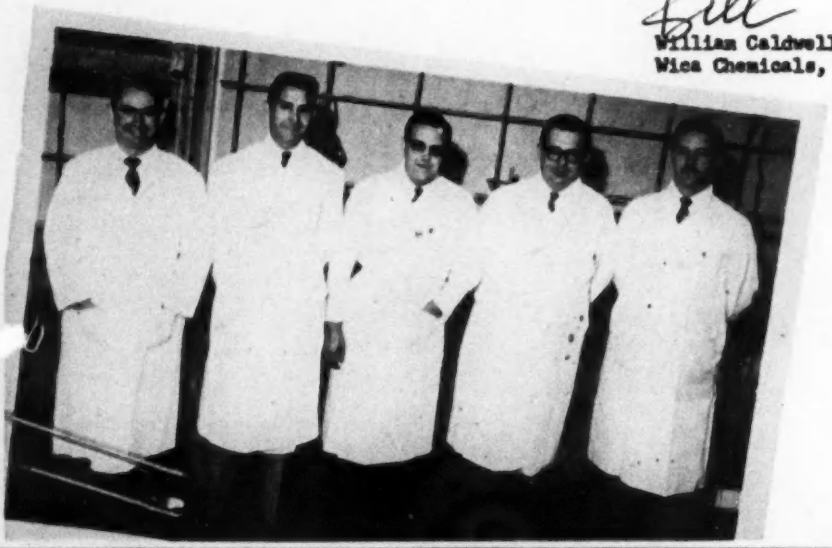

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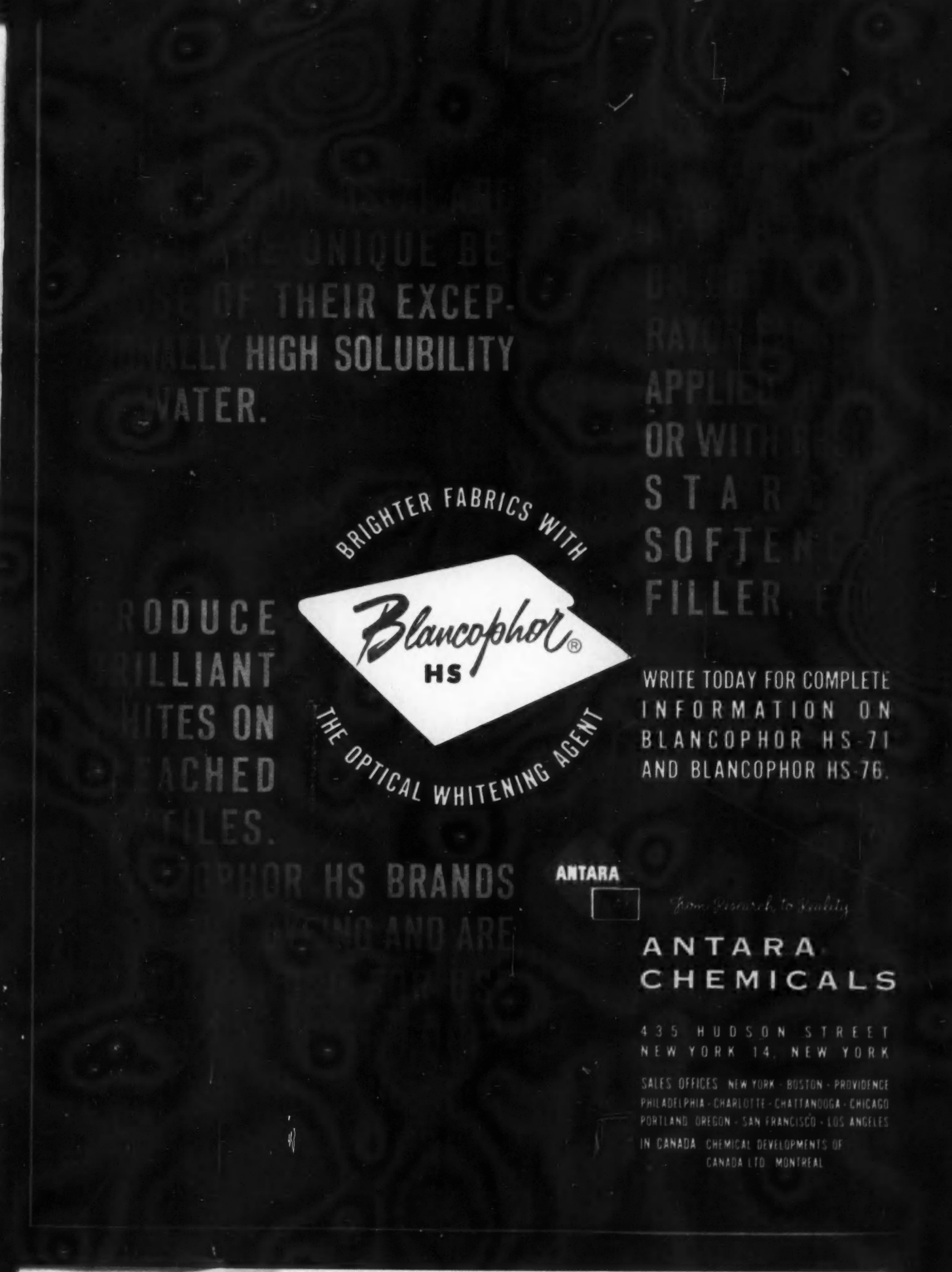
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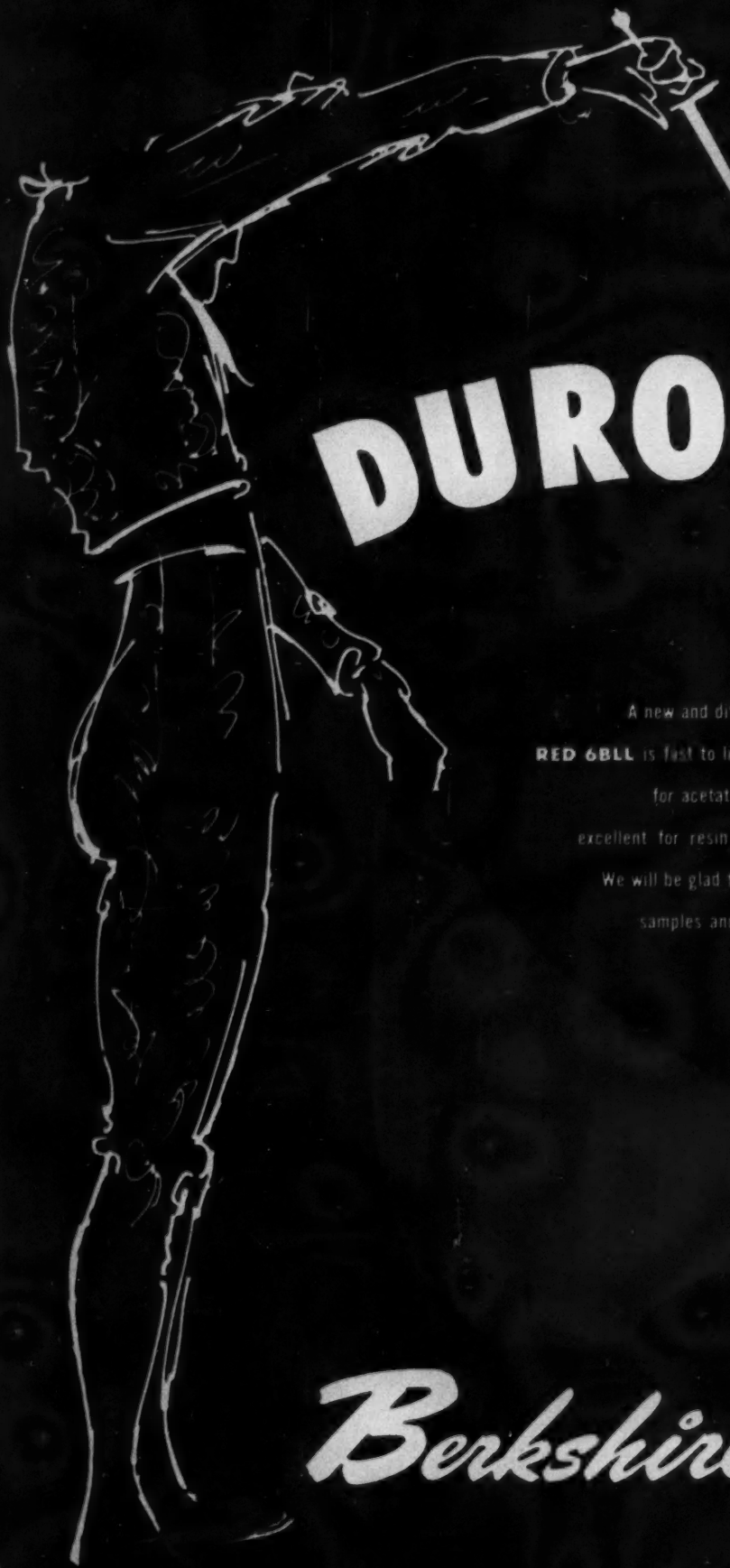

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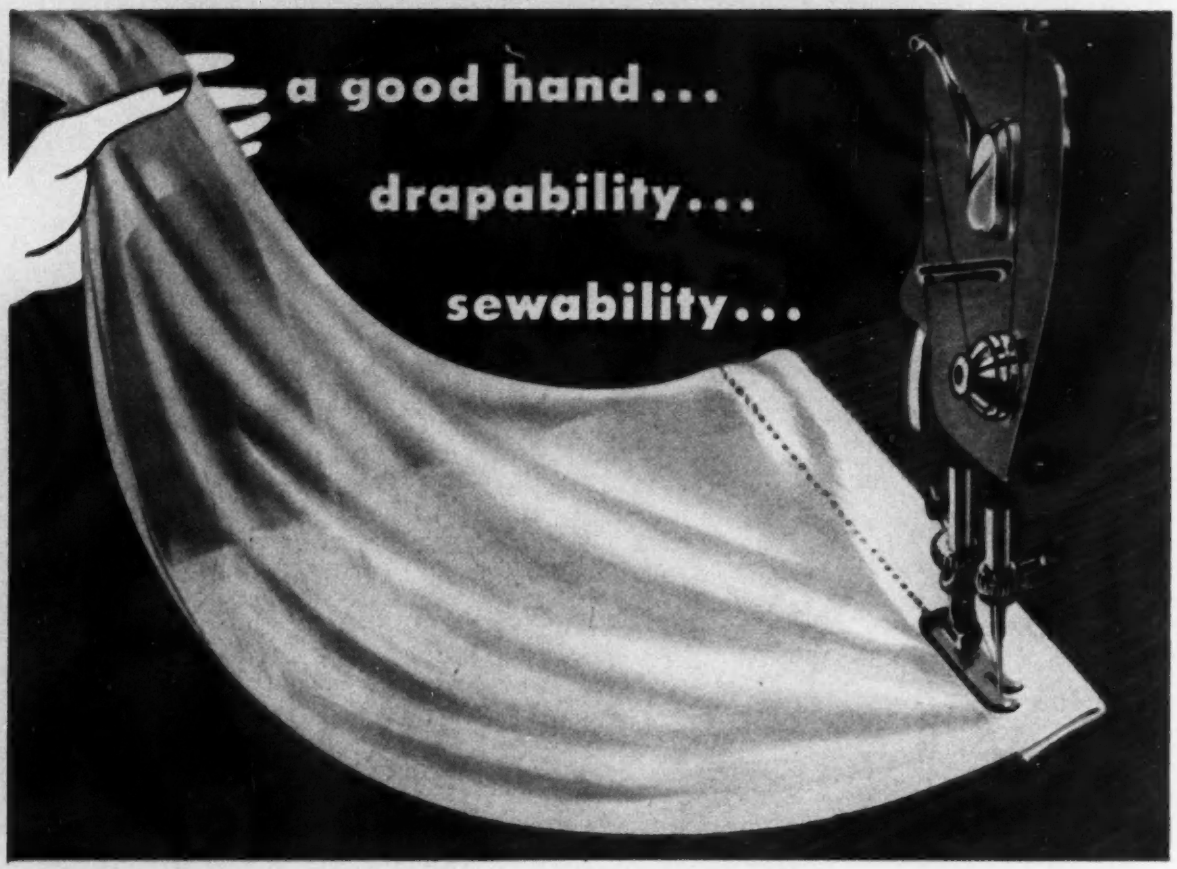

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DYESTUFF REPORTER

Devoted to Textile Chemistry
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DYESTUFF REPORTER

VOLUME 44 AUGUST 1, 1955 NUMBER 16

IDENTIFICATION OF INSECT DAMAGE ON WOOL AND RELATED ANIMAL FIBERS

DONALD J OTT

Research Laboratory
Geigy Chemical Corporation
Bayonne, N J

INTRODUCTION

THE past several years have witnessed an increasing interest among American textile manufacturers in products which will impart durable mothproofing effects. One such product commercially available to them, ie, Mitin FF Conc (a chlorinated complex substituted urea), has been described by Ferguson & Ott *(5)*. Permanent-type mothproofing agents have chemical properties similar to wool dyestuffs and are, in effect, colorless dyestuffs. In many cases they are applied to the goods during the dyeing process, the dyes and the mothproofing agents being used in the same dyebath.

These products are used for protecting garments (eg, coats, sweaters, etc), blankets, upholstery fabrics, rugs, and other materials made from wool or blends of wool and other fibers. Protection is afforded for the normal usable life of the material.

In this laboratory, we have had occasion to identify the cause of damage to garments which were returned for examination in connection with the mothproofing work on Mitin. In most cases the injury was not caused by insects but rather by cigarette burns, mechanical damage or other types of injury that often closely resemble damage by fabric pests. This paper summarizes some of the available information and also presents our experience in the identification of various types of damage on wool and related animal fibers.

DISCUSSION

Since *moth damage* is defined as damage by insect larvae that are able to digest wool or other similar keratinous fibers (eg, camel hair, cashmere, vicuna), we are primarily concerned with only two groups of insects—clothes moths and carpet beetles. The list of insect species shown in Table I includes the widespread, as well as the relatively local, species of clothes moths and carpet beetles in North America.

Occasionally wool or other fabrics may be incidentally attacked by insects, such as termites, crickets, etc, which are not normal keratinous feeders. Due to accidental proximity to the fabric, however, they may chew through mothproofed woolen textiles, synthetics, or even fabrics made of spun glass. However, these insects are not included in the National Better Business Bureau's definition of moth damage *(1)*:

> "Moth damage from the consumer point of view means damage caused by insect larvae, which have the power to ingest keratin from animal fibers, that is, clothes moth larvae and carpet beetle larvae. Keratin is a nitrogenous compound that forms the essential ingredients of horny tissue, as of horns, claws, nails, feathers, hair and wool."

It should be noted that mothproofing agents such as Mitin, which are chemically bound to the wool fiber, do not exert an insecticidal effect unless released by the action of keratinase in the digestion of the wool; therefore they are not effective against these incidental or accidental insect feeders. Zinkernagel *(30)* has illustrated this in the laboratory by confining mealworms *(Tenebrio molitor)* on Mitin-treated wool baited with yeast extract. The mealworms ate the treated woolen fibers but were not harmed by such a diet because the Mitin remained bound to the fiber and was quantitatively excreted with the undigested fragments of wool in the excrement.

A partial list of the insects which are unable to digest keratin, but which will occasionally injure fabrics, is shown in

TABLE I

PARTIAL LIST OF INSECTS IN NORTH AMERICA RECORDED AS ATTACKING KERATINOUS FIBERS

LEPIDOPTERA	Oecophoridae	*Endrosis lactella* (Schiff.)	White-shouldered house moth *(12, 13, 18)*
		Hofmannophila pseudospretella (Stainton)	Brown house moth *(12, 13, 18)*
	Tineidae	*Monopis crocicapitella* (Clemens)	*(6, 18)*
		Monopis rusticella (Clerck)	*(6, 18)*
		Tinea columbariella Wocke	*(3)*
		Tinea pellionella (L.)	Casemaking clothes moth *(15)*
		Tineola bisselliella (Hum.)	Webbing clothes moth *(15)*
		Tineola walsinghami (Busck)	Plaster bagworm *(27)*
		Trichophaga tapetzella L.	Carpet moth *(15)*
COLEOPTERA	Dermestidae	*Anthrenus flavipes* Leconte	Furniture carpet beetle *(15)*
		Anthrenus lepidus (Leconte)	Bird-nest carpet beetle *(9, 15)*
		Anthrenus museorum (L.)	Museum beetle *(9, 15, 18)*
		Anthrenus scrophulariae (L.)	Carpet beetle *(15)*
		Anthrenus verbasci (L.)	Varied carpet beetle *(15)*
		Attagenus pellio (L.)	Fur beetle *(9)*
		Attagenus piceus (Oliv.)	Black carpet beetle *(15)*
		Attagenus schaffori (Herbst)	Rodent-nest carpet beetle *(15)*
		Trogoderma ornatum (Say)	Cabinet beetle *(28)*
		Trogoderma versicolor (Creutzer)	Larger cabinet beetle *(9, 28)*

TABLE II

PARTIAL LIST OF INSECTS IN NORTH AMERICA RECORDED AS INCIDENTALLY ATTACKING FABRICS

COLEOPTERA	Anobiidae	*Lasioderma serricorne* (F.)	Cigarette beetle *(4)*
		Stegobium paniceum L.	Drug-store beetle *(28)*
	Cerambycidae	*Monochamus titillator* F.	Southern pine sawyer *(8)*
	Corynetidae	*Necrobia rufipes* Deg.	Red-legged ham beetle *(15)*
	Dermestidae	*Dermestes ater* Deg.	Black larder beetle *(28)*
		Dermestes lardarius L.	Larder beetle *(9, 28)*
		Dermestes maculatus Deg.	Hide beetle *(9, 15, 28)*
		Thylodrias contractus Mots.	Tissue-paper beetle *(9, 15)*
	Lyctidae	*Lyctus spp.*	Powder-post beetles *(28)*
	Ostomidae	*Tenebroides mauritanicus* L.	Cadelle *(15)*
	Ptinidae	*Gibbium psylloides* Czemp.	Hump spider beetle *(15)*
		Niptus hololeucus Fald.	Yellow spider beetle *(15)*
		Ptinus tectus Boieldieu	Australian spider beetle *(15)*
	Tenebrionidae	*Tenebrio molitor* L.	Yellow mealworm *(30)*
CORRODENTIA	Atropidae	*Trogium pulsatorium* (L.)	Larger pale bucklouse *(12)*
HYMENOPTERA	Formicidae	*Solenopsis aylani* McCook	Southern fire ant *(25)*
ISOPTERA			Termites *(4)*
LEPIDOPTERA	Phalaenidae	*Litoprosopus coachellae* Hill	Fan palm caterpillar *(2, 7)*
	Tortricidae	*Carpocapsa pomonella* (L.)	Codling moth *(30)*
ORTHOPTERA	Blattidae	*Periplaneta australasiae* F.	Australian cockroach *(15)*
	Gryllidae	*Acheta assimilis* F.	Field cricket *(15)*
		Acheta domestica L.	House cricket *(15)*
	Tettigoniidae	*Ceuthophilus spp.*	Camel crickets *(28)*
THYSANURA	Lepismatidae		Silverfish & Firebrats *(15)*

Table II. In addition, rats, mice and squirrels sometimes use woolen or other fabrics to make nests.

METHODS FOR DETECTING MOTH DAMAGE

Various methods for detecting moth damage have been described in the literature, but the most unusual technique is the one developed by Mosher *(19)*. This is a chemical method based on the presence of uric acid in the excrement of the clothes moth and carpet beetle larvae. A positive analysis for uric acid with fibers from the damaged area indicates damage by moths.

MICROSCOPIC EXAMINATION —— The most commonly used method involves a thorough microscopic examination of the damaged areas for insect refuse, such as webbing, excrement, etc, and also microscopic examination of individual damaged fibers for mandible imprints or other characteristic marks. This is the method currently used at this laboratory and it involves the use of two different types of microscopes, the wide field stereoscopic binocular type and the monocular type.

1) *Wide-field Stereoscopic Binocular Microscope*——With this type a preliminary examination of the general area of damage is made at a magnification of 10X (low-power) in order to detect flaws in the appearance of the entire area, such as nap removal, concave pits, etc. Obvious refuse, such as webbing and cast skins, can also be seen at this magnification.

For a preliminary examination of individual fibers in their normal position in the damaged area, the high power (45X) is used. This will sometimes show obvious mandible imprints, or the swollen fibers associated with burns, and thus help in locating fibers that look promising for mounting on slides. Carpet beetle hairs can also be seen at this magnification.

The damaged fibers are cut with a special scissors under medium power (20X) because the movement is too great under higher magnification. The cut fibers are removed from the material with forceps and mounted in Canada balsam on a slide under low power (10X).

2) *Monocular Microscope* —— Most mandible imprints and burnt fiber ends can be detected under medium power (100X) with Canada balsam mounts and a monocular microscope. However, the high power (450X) is very useful for checking suspicious areas found with the medium power.

For the purposes of this paper, special tests were run with woolen fabric exposed to the three species of fabric pests cultured at this laboratory—webbing clothes moth, black carpet beetle, and furniture carpet beetle larvae. Therefore, with the exception of the damaged fibers shown in Fig 5, the species involved were known and single fibers were mounted specifically for photomicrographs. The fibers shown in Fig 5 are from an untreated cashmere coat that was damaged by unknown species in the field and sent to this laboratory for examination. These are typical of routine mounts of cut fibers from the damaged areas on an untreated garment.

ADDITIONAL METHODS——Zinkernagel *(29)* describes an interesting method for detecting insect refuse on the damaged areas. A thin layer of nitrocellulose cement is applied to two glass slides. When the cement is almost dry, one slide is pressed firmly against one side of the damaged area and the second slide is pressed against the other side. The slides are then removed and, when the cement is dry, they are examined under the microscope for fabric-insect refuse, such as carpet beetle hairs, moth scales, etc. By using a graduated mechanical stage, one may carefully examine the entire surface and relocate particular spots on the slide. A magnification of about 50X is sufficient for routine examination. If any of the debris appears to be insect parts, a higher magnification is used for closer observation. For best results with this method, it is important that the garment not be washed, drycleaned or brushed. Furthermore, it is essential that a special room and microscope be used in order to avoid any possible contamination with scales or hairs from the rearing-room cultures.

Meeuse et al *(16, 17)* describe microscopic methods for detecting damage on woolen fibers. Fibers damaged by heat, acids, alkalis, micro-organisms, and insects are illustrated in a large series of photomicrographs. Ryberg *(24)* also illustrates woolen fibers damaged by bacteria and by various manufacturing processes, such as carbonizing and stripping. In both of these papers and in the paper by Krauss *(10)*, the emphasis is on damage which occurs during the manufacturing process rather than damage which occurs during actual use of the finished goods.

TYPES OF DAMAGE

CLOTHES MOTH DAMAGE —— The methods for identifying damage by clothes moths have been described in several papers *(18, 20, 23, 26)*, which illustrate the webbing, feeding tubes, excrement, etc associated with feeding by this group of fabric pests. In some cases, clothes-moth refuse can be readily identified without a microscopic examination. However, if the refuse has been removed by brushing or drycleaning, a thorough microscopic examination will be necessary. Ordinarily some bits of webbing remain in obscure feeding channels and even minute amounts can be seen with a wide-field microscope at the highest magnification (45X). Usually it is also possible to detect mandible imprints by mounting the damaged fibers in Canada balsam and examining them under a microscope (100X). The imprints are detected most readily on the coarse fibers (see Fig 1).

A paper by Reumuth *(23)* includes excellent photomicrographs of both clothes moth mandible imprints and wing scales. Zinkernagel *(29)* also illustrates adult moth scales, which can be detected by his method on moth-contaminated fabrics.

CARPET BEETLE DAMAGE——— The main difficulties are encountered in identifying damage by carpet beetles. According to Ferguson *(4)*, these insects account for more damage than clothes moths in the northern states. Since they do not spin webs, carpet beetles rarely leave refuse on the fabric as is the case with clothes moths. However, it is sometimes possible to locate pieces of cast skin or even individual hairs with the wide-field microscope. Hairs from black carpet beetle larvae are the most difficult to identify because they lack the characteristic ornamentation and spear-points found on hairs from caudal tufts of *Anthrenus* and *Trogoderma spp (9, 22, 29)*.

Fortunately, carpet beetle injury can usually be detected in the laboratory by microscopic examination of the damaged fibers for mandible imprints (see Figs 2 and 3). These imprints are usually larger and much more clearly defined than those associated with clothes-moth larvae.

Krauss *(11)* includes an excellent illustration of damage to casein fiber by a carpet beetle species. And the characteristic appearance of the fibers shown in Fig 5 indicates that they also undoubtedly involve one of the carpet-beetle species.

Due to their burrowing habit, black-carpet-beetle larvae generally leave pits on napped fabric. When these pits penetrate the base yarns, the fibers are usually cut in such a way that they have an almost perfect concave appearance at the base of the pit. Usually this concave appearance is readily observed with the wide-field microscope.

Nap removal by carpet beetles of the *Anthrenus* group is less characteristic and superficially resembles nap removal by clothes moth larvae. However, the furniture carpet beetle *(Anthrenus flavipes)* tends to be gregarious when feeding and often a number of individuals will remove the nap in one large area—usually at the edge of the fabric. The mandible imprints of this species are indistinguishable from those of the black carpet beetle larvae.

INCIDENTAL FABRIC PEST DAMAGE———As mentioned previously, insects which feed elsewhere may occasionally gain accidental entry to the house and attack fabrics. According to Lintner *(14)* crickets have been known to ruin a suit of clothes overnight. This sort of damage could occur regardless of treat-

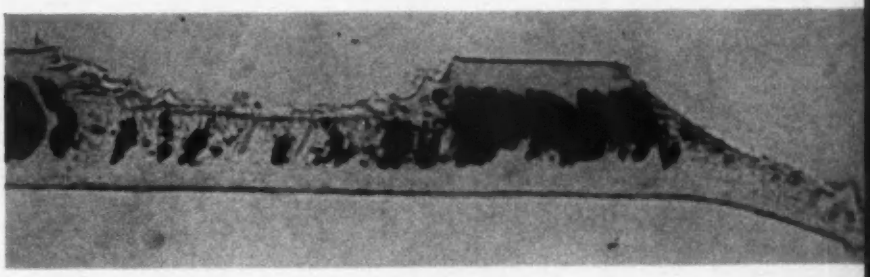

Figure 1
Webbing clothes moth mandible imprints on a coarse wool fiber. (X180)

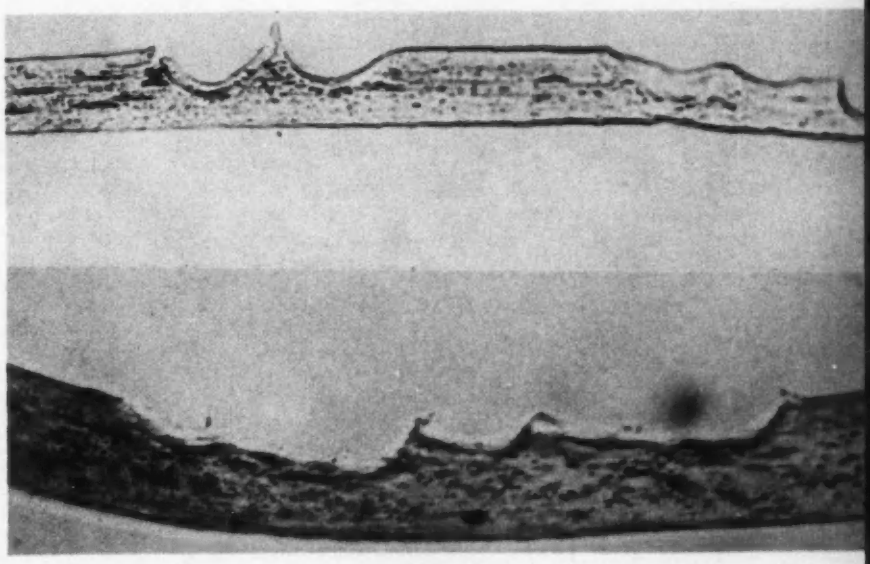

Figure 2
Black carpet beetle mandible imprints on wool fibers. (X200)

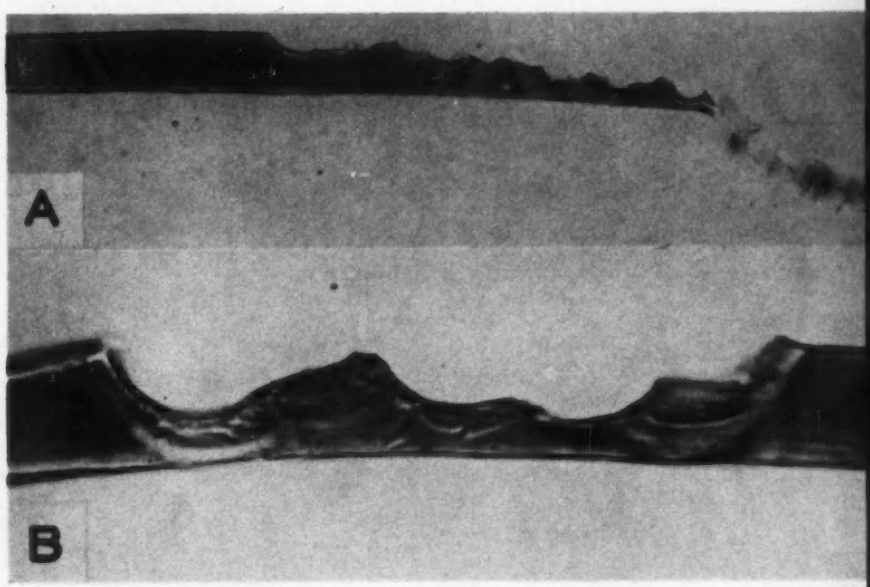

Figure 3
Furniture carpet beetle mandible imprints on wool fibers. A. (X200) B. (X450)

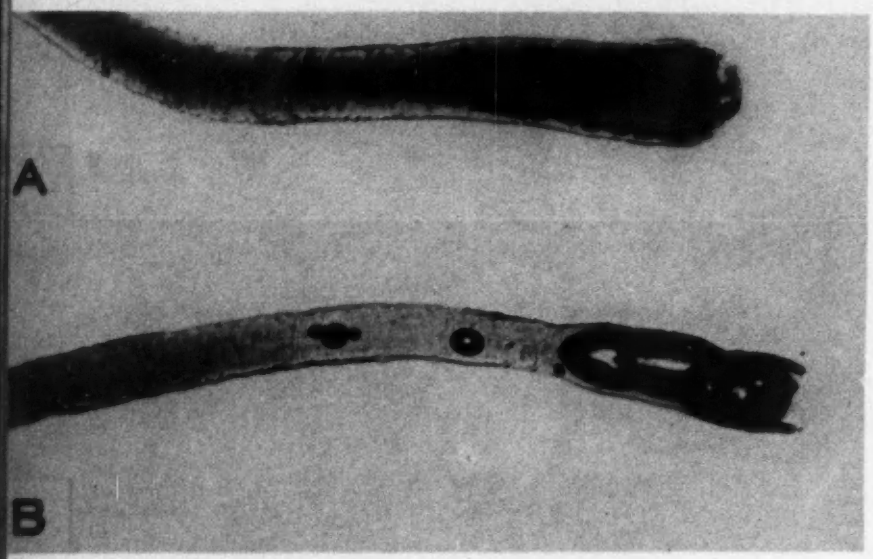

Figure 4
Burnt fibers. A. Wool (X200) B. Cashmere (X200)

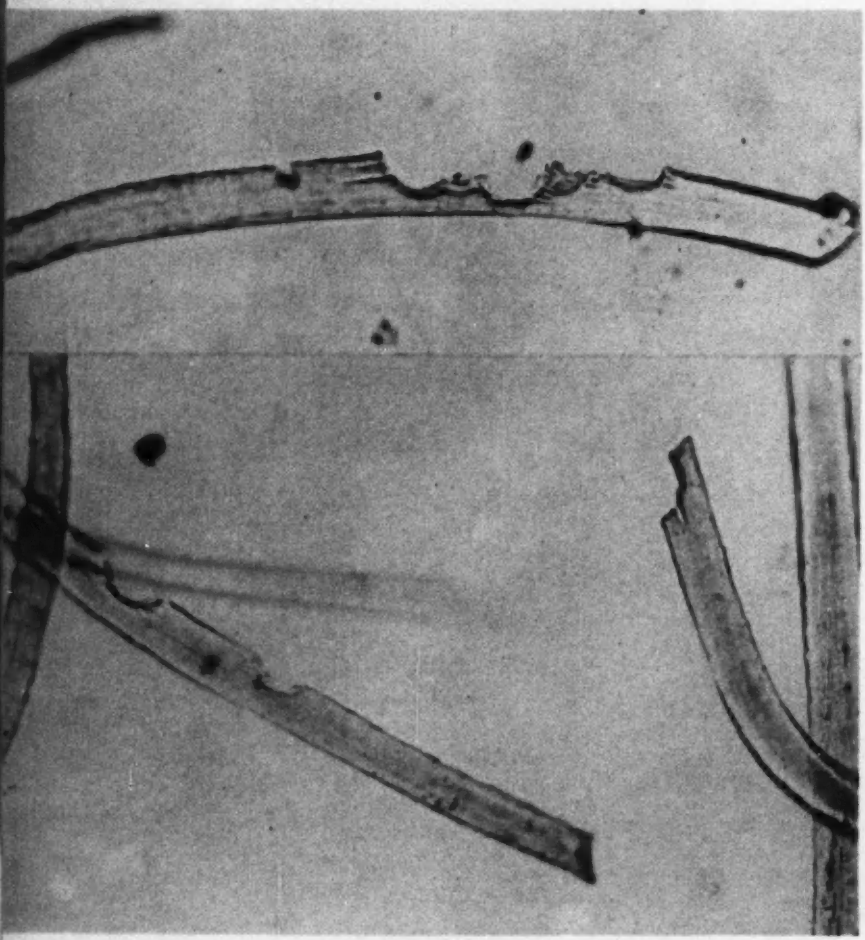

Figure 5
Fibers from an untreated cashmere coat damaged by an unknown species in the field. (X200)

ment or type of fabric. The list of insects which have been reported as incidental fabric pests (Table II) is quite long but this type of damage is rare and relatively unimportant when compared with the enormous damage caused by the various species of clothes moths and carpet beetles. In some cases, incidental damage of this type is difficult or impossible to distinguish from mechanical injury since these insects may often be large enough to cut across most fibers without leaving evidence in the form of mandible imprints. Hence, it is usually necessary to have the insect, or at least some parts, available for examination. Two examples of damage by incidental fabric pests have been encountered to date on the garments sent to this laboratory for examination.

1) *Cerambycid Beetle*——The first case involved a damaged sweater from store stock. Both the cardboard box and the sweater were damaged and a large beetle was found in the box. Upon examination, it was identified as a wood-boring beetle belonging to the family Cerambycidae. The beetle probably emerged from new lumber in the vicinity and caused the damage by chewing through the box and the sweater. Gerberg *(8)* reports a similar instance of injury by the same type of wood-boring beetle. The adult beetles were discovered chewing a number of large holes in rayon dresses in a show window in Maryland. The beetles were identified as southern pine sawyers (*Monochamus titillator* F). These insects feed on pine and other coniferous trees during the larval stage. The proprietor of the store stated that a few pieces of new lumber had been used in making the show-window, but it was not possible to ascertain whether the beetles had emerged from the wood.

2) *Fan Palm Caterpillar*——The second instance of damage by an incidental fabric pest was encountered recently when a coat was received from Palo Alto, Calif. The damage was limited to the cuff of the sleeve where the nap was removed on several large areas (½ to ¾ inch dia), and in one case a hole was apparent through the base yarns. A chemical analysis with fibers from the sleeve revealed an adequate Mitin application.

Fortunately, the damage had been discovered by a drycleaner who then removed and saved the "moth nest" (matted cut fibers and insect refuse) before cleaning the coat. Part of this material was sent in an envelope along with the coat.

Microscopic examination of the cut fibers did not reveal any evidence of fabric insect damage, such as typical webbing and mandible imprints. However, three small pieces of an insect larva were found: two pieces from the side of the larva and a small portion of a thoracic

leg complete with tarsal claw. The appearance of these insect parts and the presence of some strands of silk in the entangled mass of cut fibers indicated the possibility of a lepidopterous larva being involved, but the insect parts in no way resembled any of the various species of clothes moths. Hence it was assumed that this was another instance of damage by an incidental fabric pest. A search through the literature revealed a description of a species that fitted this case in all respects.

According to Flock *(7)*, larvae of *Litoprosopus coachellae* Hill (fan palm caterpillars) feed in the flowers and fruits of the fan palm in California, and they normally make their cocoons of the tough fibers at the base of the trees. However, they occasionally enter houses and remove the pile in large patches from rugs, draperies and other household fabrics in the process of making cocoons. Flock states further that "since the feeding and moving about usually occur at night, the caterpillars are rarely observed. They commonly enter buildings when large numbers of mature individuals are blown from trees by wind, but a certain number fall or travel to the ground regardless of wind conditions. When on the ground the caterpillars appear to be attracted to lights so that they are likely to enter buildings before finding a suitable place to pupate."

The above report describes caterpillars observed at Riverside, Calif, but Armitage et al *(2)* state that, although this caterpillar is a native of southern and Lower California, it has followed the plantings of these common ornamental palms up into the Sacramento Valley. Subsequent to our examination of the damaged coat, an investigation in Palo Alto proved that this palm was prevalent in that area. Furthermore, the insect parts—particularly the tarsal claw—agree with the illustrations by Peterson *(21)* of similar parts from other members of this same family (Phalaenidae).

BURNT FIBERS———Burns often closely resemble insect damage when examined superficially since, in most cases, the nap is removed in small areas and the charred ends of the fibers have usually fallen off due to handling. However, microscopic examination of the damaged areas invariably reveals some fibers with swollen, discolored ends. These remain intact and almost always contain characteristic bubbles which have been trapped in the swollen ends of the fibers and can be readily seen under a microscope (see Fig 4). The discoloration is usually amber to brown in color regardless of the color of the fibers, although on some blue fibers it may be a greenish yellow. For a check, the discoloration and other characteristics of burnt fibers obtained with any particular color or type of fiber can be duplicated in each case by scorching a few fibers with a match.

MECHANICAL INJURY—Mechanical injury is usually indicated by the lack of fabric-insect refuse, mandible imprints, and burnt fibers. It is particularly apparent if some of the damage is in the form of diagonal slashes, series of holes in a straight line, snags, right-angle tears, etc.

An example of this type of injury was reported by a woman who found damage on the right sleeves of all of her sweaters. Upon investigation, she discovered a stapled drycleaning tag with a sharp point projecting from the lining of her coat sleeve.

With very few exceptions, practically all of the laboratory examinations resulted in clear-cut conclusions. However, there have been a few cases where the damage appeared to be due to mechanical causes, but the possibility of fabric insect damage was not completely excluded. Two factors are usually involved in these indefinite cases:

1) *Insufficient Damage*—The damage may be so slight that insufficient cut fibers are available for microscopic examination.

2) *Fine Fibers*—Fabrics with uniformly fine fibers, eg, cashmere sweater material, may present difficulties. Fewer mandible imprints are present than on thick fibers because the larva can cut completely through a very thin fiber with a single bite. This is particularly true if mature larvae are involved.

Cashmere material used in coating does not present this difficulty because it ordinarily includes a small percentage of coarse fibers. Mandible imprints can be located easily by examining these thick fibers. The imprints shown in Fig 5 are typical of damaged fibers on untreated cashmere coating material.

CHEMICAL ANALYSES

The reports on the results of these biological examinations have been in good agreement with the results of the chemical analyses supplied afterward. In one case, fabric insect damage was discovered on the sleeve of a coat with an adequate Mitin treatment. Further investigation revealed that the sample for analysis was taken from the body of the coat and an analysis on the sleeve itself indicated that, by oversight, the sleeve had been made with material not treated with Mitin.

SUMMARY

Methods are described for identifying various types of damage to woolen fabrics. The method most commonly used by this laboratory in connection with the mothproofing work on Mitin involves a microscopic examination of the fabric for insect refuse and mandible imprints. Photomicrographs of woolen fibers damaged by three common species of keratinous feeders (webbing clothes moth, black carpet beetle, and furniture carpet beetle) are included as well as photomicrographs of burnt fibers. Incidental damage to fabrics by nonkeratinivorous insects is also discussed and a partial list of these species is included.

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INDEX TO PATENT DIGEST

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Brit P 709,735 (Bleacher's Assoc Ltd) 503 (1955)
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FOR the convenience of readers of the Patent Digest, we are pleased to review the system of identification and key numbers which are used by Dr Wengraf to classify the patents.

The following list is a revision of the list which appeared last on July 1, 1946 at the time of the inauguration of this feature:

A. PREPARING

1. Decortication of bast fibers (flax, hemp, etc)
2. Animal fibers
   01. wool scouring
   02. preliminary treatments (oiling, carbonizing, etc)
   03. preparing for hat felts
   04. chlorinating, shrinkproofing wool
   05. crabbing
3. Fulling
4. Sizing
   01. sizing
   02. desizing
5. Immunizing
6. Mercerizing
   01. processes and equipment
   02. special wetting agents for mercerizing
7. Preparing of cotton cloth and rayon fabric
   01. chemical: preliminary treatments
   02. mechanical: singeing, warping, etc

B. BLEACHING

1. Improvements of the usual chlorine bleach
2. Bleaching with peroxides
3. Bleaching equipment
   01. for standard bleach
   02. full-width bleaching and oxidation bleaching
4. Bleaching equipment and processes for animal fibers.
5. Optical bleaching, miscellaneous

C. DYEING

1. General auxiliary processes, stripping
2. Mordanting of fibers
3. Washing and soaping
   01. general
   02. degumming (boil-off)
   03. foam dyeing and emulsion dyeing
4. Dyeing with different classes of colors
   01. substantive and basic colors
   02. vat colors and sulfur dyestuffs
   03. Indigosols and naphthols
   04. mordant dyes
   05. aniline black
   06. acid dyestuffs and acid chrome dyestuffs
   07. special processes for synthetic fibers, cellulose esters and ethers
5. Dyestuff pastes and colloidal powders, also for printing
6. Dyeing machines of all kinds

D. PRINTING

1. General thickenings
2. Special printing processes
   01. vat colors and sulfur dyestuffs
   02. printing: reduction, reserve, discharge style
   03. substantive and basic colors
   04. Indigosols and naphthols
   05. mordant dyes
   06. acid dyestuffs and other special processes for animal fibers
   07. special processes for synthetic fibers, pigment printing
3. Printing machines of all kinds
4. Spray, screen printing
5. Steaming
6. Methods of engraving

E. TEXTILE AUXILIARIES

1. From resinous products
2. From naphtha and naphtha residues
3. Fatty alcohol sulfonates and related products; condensates of fatty acids
4. Quaternary ammonium bases and amino compounds
5. Others

F. SYNTHETIC FIBERS

1. General, shaping of filament, artificial staple fiber
2. Different spinning solutions
   01. viscose
   02. cuprammonium
   03. ester rayon and ether rayon
   04. cellulose compounds containing nitrogen
   05. solutions of fibroin, casein fibers
   06. synthetic fibers, latex, resins, glass
3. Delustering
   01. delustering before and during spinning
   02. delustering after spinning
4. Special kinds of finishes
   01. crepe
   02. others*

G. FINISHING

1. Antitarnish, antistatic, fading prevention, antimicrobial, general finishing methods
2. Special finishing processes
   01. permanent finishes
   02. water repellent and water proof
   03. fireproof
   04. crease resistant, stabilizing fibers except wool, setting
   05. softening, avivage
   06. weighting and other special finishes for silk
3. Finishing equipment and drying methods
4. Calendering, moiré, and printed calendar effects
5. Dampening, moistening, conditioning
6. Raising, napping

H. GENERAL

1. Structure of the fibers, starch, gums, etc
2. Laboratory
   01. new methods
   02. apparatus
3. Spotting and cleaning
   01. aqueous agents (wet)
   02. non-aqueous agents (dry)
4. Colorimetry and color theory, exposure to the light
5. Management
   01. power plants
   02. materials
   03. interiors, air conditioning
   04. plant injuries
   05. plant difficulties and their remedies
6. Water softening waste water purification
7. Economics, statistics

* With the exception of the finishing processes proper of rayon.

ABSTRACTS

Classifying Detergents

J V Karabinos, G E Kapella, and G E Bartels, *Soap Chem Specialties* 30, 41-3, June, 1954.

The systematic classification of the various organic detergents present in commercial mixes has always presented a difficult problem. With the advent on the market of a host of new synthetic detergents, particularly of the nonionic variety, the earlier methods of differentiation are somewhat incomplete. The object of this study is to provide a convenient series of simple tests which give even an inexperienced laboratory worker a method for classifying the anionic and nonionic detergents into their various subgroups.

The majority of the synthetic detergents belong to the anionic and nonionic types. A table is included in which a large number of the commercial products are classified in 14 categories according to their chemical constitutions, which are given.

The following reagents are recommended by the authors for qualitative tests to distinguish between the different types:

1) Ceric nitrate reagent
2) Chloroform-aluminum chloride
3) Bromine water
4) Potassium permanganate
5) Alcoholic potassium hydroxide solution
6) Acetic anhydride and sulfuric acid

Instructions are given for the application of these reagents, and a table is included, giving the action of each reagent on all of the 14 types of detergent.

The authors state that this method of testing has been used successfully with a number of detergents in each category. It naturally becomes less effective in cases where mixtures of detergents are present. It is recommended that all six tests be performed on every detergent.—WHC.

Shrinkage of Cotton Broadcloth Shirts

M A Grimes and C A Werman, *Modern Textiles* 35, 48, 71-3, March, 1954.

Despite the fact that preshrunk fabrics are available in yard goods and in garments, shrinkage continues to be a major problem of the consumer. There are numerous complaints that garments become unwearable because of shrinkage long before the fabric is worn out.

For some time considerable doubt has been expressed as to whether one laundering by the usual recommended test method (eg, of ASTM) is severe enough to predict the shrinkage that will occur during the normal life of a garment.

The authors review briefly the work of earlier investigators in this field. They then give the results of their own tests on cotton broadcloth shirts. These tests included laundering both in commercial laundries and in the laboratory, and ironing both with a rotary ironer and with a hand iron. The laundering tests were repeated at least 20 times, and in some cases 68 times. The results of these tests are summarized as follows:

1) Commercial laundering caused greater shrinkage than laundering by household methods. Hand ironing resulted in greater shrinkage than ironing with a rotary ironer.

2) By the 20th and 68th laundering, when washed by household methods and ironed with a rotary ironer the shrinkage was one half, and when hand-ironed, two thirds that of commercially laundered shirts.

3) By none of the methods of laundering was the shrinkage more than approximately three-fourths complete after only five launderings.

4) The direction of ironing affected the shrinkage of both warp and filling.

5) The Sanforized broadcloth shirts at the first commercial laundering shrank in the warp from 1.2 to 2.4%, approximately one third to two thirds of the total shrinkage.

6) Filling changes ranged from a gain of 1.1% to a loss of 1.1%.

7) Collar bands shrank an average of one-half inch.

8) The broadcloths varied considerably in shrinkage, although all were Sanforized. All shrank much more than one percent.—WHC

Mothproofing Wool with DDT

A S Weatherburn and C H Bayley, *Soap Chem Specialties* 30, 141-4, 163-7, September, 1954.

The mothproofing of wool blankets is a subject of interest alike to the housewife and the launderer or the cleaner. Some brands of blankets now carry a guarantee of permanent protection against insect attack, having been treated during manufacture with one or other of the comparatively limited number of substantive compounds which remain in the fabric throughout its life. In other cases, where a less permanent compound has been used, and where the blanket has been subjected to a number of washings, it may be desirable to restore its original insect resistance. However, it is probable that the majority of wool blankets sold on this continent have not been treated in any way, and hence the most convenient ways of doing this are of considerable interest to the launderer and cleaner who frequently undertakes to "mothproof" blankets as an added service.

A number of nondurable compounds (eg, DDT and methoxychlor) are in current use by drycleaners, who apply them in solution in drycleaning solvent as a final rinse following the cleaning operation.

The compound DDT has recently become available in the form of water-dispersible concentrates suitable for use in laundering operations, and the purpose of this work was to investigate the feasibility of applying DDT in this form during the laundering of woolen goods, and also to determine the resistance to moth attack of wool so treated. In view of the increasing use of synthetic detergents in the commercial laundering of wool, three of these, two anionic and one nonionic, were included, along with soap. Two commercial preparations of DDT were used.

Experiments carried out in a Launder-Ometer, followed by a commercial-scale trial, are described by the author.

Among the conclusions reached, it was found that there was a selective pickup of the DDT from the bath which was comparatively rapid. The presence of detergent in the treating bath interfered with the take-up of DDT. Subsequent washing with detergent removed the DDT from the wool, but it was not removed by water alone. In the full-scale trial, the cost of the treatment was estimated to be about ¾-cent for an average-size blanket.

Seven references to the literature are cited.—WHC.

The Dyeing and Finishing of Knitted Fabrics

J Neubert, *Textile J Australia* 29, 706-19, August, 1954 (from *Textil-Praxis*).

The practical dyer will find in this paper much information on the bleaching, dyeing, and finishing of knitted fabrics, composed not only of cotton but also of viscose, cuprammonium, Perlon, and nylon, both alone and in mixtures. Although the dye names all refer to the products of a certain German manufacturer, many of them will be recognized as having American equivalents.

Under "dyeing" the discussion is limited to direct, direct aftertreated, and developed dyes. The author suggests that with certain dyes the operations of bleaching and dyeing can be combined in the same bath.

In dyeing pigmented viscose not all dyes are equally suitable. The author gives a list of the dyes that are particularly sensitive.

The dyeing of solid shades on mixtures of cotton and viscose fibers presents problems that have not yet been completely solved, due to the higher affinity of viscose for most direct dyes. The author suggests a few measures that may help to overcome this difficulty (eg, careful selection of dyes, and control of temperature and salt addition).

Cuprammonium rayon is different from cotton and rayon in many respects. It has a considerably higher affinity for dyes, and only those dyes that level out easily in the course of the dyeing process should be used. Mixtures of cotton and cuprammanium cannot be dyed in solid shades unless the cotton is mercerized.

Instructions are given for bleaching Perlon and nylon with chlorite. Hypochlorite and peroxide are not suitable.

These man-made fibers are used on a large scale for blending with viscose, cuprammonium, and cotton, to improve resistance to abrasion. To produce solid shades on these blends, a considerable number of direct dyes, which are listed, may be used. Direct dyes do not go on to Perlon and nylon "substantively", as on cotton, but are chemically bound, like acid dyes on wool. The affinity of the dye for the vegetable fiber is increased by salt addition, while the dyeing of Perlon and nylon is promoted by the addition of acids, and also by boiling temperature.

A list of suitable direct dyes for leaving Perlon and nylon undyed is also included. —WHC.

NOTE

ON PAGE 305 of the April 25th issue there appears in the third column the following footnote:

* The term "Indigosols" comprises all kinds of sulfuric acid ester salts of leucovat dyes regardless of their provenience.

Actually, the word "Indigosol" is a trade mark belonging to Durand & Huguenin S A, Basle, Switzerland.

The footnote should have correctly read as follows:

* The term "Indigosols" as used by the author refers to all kinds of sulfuric acid ester salts of leucovat dyes regardless of their provenience.

Proceedings of the

American Association of Textile Chemists and Colorists

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Editor of Proceedings: Carl Z Draves

August 1, 1955

AATCC CALENDAR

COUNCIL
Wednesday evening, Sept 21 (Chalfonte-Haddon Hall, Atlantic City, N J); Nov 18, Jan 20 (Hotel Statler, New York, N Y); April 20; June 15; Sept, 1956; Nov 16, 1956; Jan 18, 1957.

NATIONAL CONVENTIONS
Sept 21-24, 1955 (Chalfonte-Haddon Hall, Atlantic City, N J); 1956 (Waldorf-Astoria, New York); 1957 (Boston); 1958 (Chicago); 1959 (Washington, DC)

MID-WEST SECTION
Oct 29 (Bismarck Hotel, Chicago, Ill).

NEW YORK SECTION
Oct 14, Nov 18 (Kohler's Swiss Chalet, Rochelle Park, N J); Jan 27, Feb 24 (Hotel Delmonico, New York, N Y); Mar 23, Apr 27, May 18 (Kohler's Swiss Chalet, Rochelle Park, N J).

NORTHERN NEW ENGLAND SECTION
Oct 14; Dec 9.

PACIFIC SOUTHWEST SECTION
Oct 7, Feb 6 (Gourmet Restaurant, Beverly Hills, Calif); Dec 2.

PHILADELPHIA SECTION
Oct 21 (Penn-Sherwood Hotel); Dec 2, Jan 13 (Kugler's Restaurant).

PIEDMONT SECTION
Oct 29 (Hotel Wm R Barringer, Charlotte, N C).

RHODE ISLAND SECTION
Oct 13, Dec 1 (Johnson's Hummocks, Providence).

SOUTH CENTRAL SECTION
Dec 10 (Hotel Patten, Chattanooga, Tenn).

SOUTHEASTERN SECTION
Sept 10 (Ralston Hotel, Columbus, Ga); Dec 3 (Atlanta Biltmore, Atlanta, Ga).

WESTERN NEW ENGLAND SECTION
Sept 16 (Rapp's Restaurant, Shelton, Conn); Nov 4 (Hartford, Conn); Dec 16 (Rapp's).

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MEMBERSHIP APPLICATIONS—PAGE P540

ACTIVITIES OF THE LOCAL SECTIONS

MID-WEST———The 23rd annual outing of the Mid-West Section, held June 10-11 at Lake Lawn Lodge, Delavan, Wis, attracted 137 members and guests, in spite of inclement weather.

Twenty 2-ball foursomes played golf on Friday afternoon, with ninety-one turning out for golf on Saturday. Although the annual softball game between the Suppliers and Millmen was rained out, horseshoe pitching and shuffleboard tournaments were held.

A Saturday evening cocktail party preceded dinner and the awarding of prizes. Winners of the various golfing events were as follows:

Friday (twilight) 2-ball foursomes———1st—W A Brainerd, Munsingwear, Inc, and Frank Snyder, Copeland Milnes Wool Co; 2nd—J G Kelley and J M Remsen, E I du Pont de Nemours & Co, Inc; 3rd—A G Rathke, Contour Hosiery Mills, and F Earl Schroeder, Prospect Chemical Co.

Low gross———(millmen)—A G Rathke, 83; (salesmen)—F A Kraft, Becco Sales Corp, 77; (guest)—Frank Snyder, 77.

Low net (Flight A)———1st—A G Kidder, Western Felt Works, 85-24-61; 2nd—C J Kurowski, Mid-West Processors Inc, 84-21-63; 3rd—K M Harms, Morgan Dye & Bleaching Co, 85-21-64.

Low net (Flight B)———1st—J L Eich, General Dyestuff Co, 92-36-56; 2nd—F J Connolly, Morgan Dye & Bleaching Co, 93-30-63; 3rd—H T Latham, E I du Pont de Nemours & Co, Inc, 92-27-65, and A E Patton, Yale Woolen Mills, 92-27-65.

Low net (Flight C)———1st—William O Fischer, Milwaukee Dye & Bleaching Co, 112-57-55; 2nd—John Nerl, American Aniline Products, Inc, 116-60-56; 3rd—D A Anderson, Phoenix Trimming Co, 106-42-64.

Low net (Flight D)———1st—A A Gorski, Morgan Dye & Bleaching, 120-63-57; 2nd—B A Gale, Chicago Printed String Co, 136-78-58; 3rd—B F Smith, Dyersburg Cotton Products, Inc, 117-57-60.

Longest drive———Frank Snyder.

Closest to pin———F J Connolly.

Honors in horseshoe pitching went to Joseph D Hayes, J T Lodge & Co, in the singles event, and to the team of B Isenogle, Aurora Bleachery, Inc, and Edward A Hoffman, Geigy Chemical Corp, in the doubles competition.

In shuffleboard, H J Jayr, National Tinsel Mfg Co, took top honors, with Elmer Scharf, L Sonneborn Sons, Inc, second.

* * * * * *

SOUTHEASTERN———Two hundred and forty-three members, guests, and wives were on hand to make the sixth annual outing of the Southeastern Section the largest in its history. The event was held June 3-4 at Radium Springs, Ga.

Russell Gill, Southern Sizing Co, took low gross honors in golf, while the cup for low gross among millmen went to J Hugh Brown, Jr, Pepperell Mfg Co. Aubrey Rogers, Coats & Clark, won the singles event in horseshoe pitching; and the team of J Elwood Barbre, Pepperell Mfg Co, and James M Buckner, Muscogee Mfg Co, came out on top in the doubles competition.

Dick Henry, Textile Aniline & Chemical Co, chairman, and Bill Kennady, Arnold, Hoffman & Co, Inc, co-chairman, headed the Outing Committee, which was made up of the following members: *finance*———W T Kennedy, Pepperell Mfg Co; *entertainment*———George Caron, A & M Karagheusian Rug Co; *ladies*———George Dozier, Southern Dyestuff Corp; *registration*———Ed Ravenel, Morton Salt Co; *horseshoes*———Elwood Barbre; *golf*———Dave Meriwether, Seydel-Woolley & Co; *photography*———Claude Suttle, Southern States Chemical Co; and *prizes*———Dwight Turner, Arnold, Hoffman & Co, Inc.

(See page P539 for Southeastern Section outing photos)

New York Section———

DYEING, FINISHING, AND HEAT-TREATING ARNEL* TRIACETATE†

FRED FORTESS

Summit Research Laboratories
Celanese Corporation of America
Summit, New Jersey

INTRODUCTION

THE advent of a new fiber has an impact on every phase of the textile industry. Normally, it takes many years to utilize the specific physical and chemical properties of a new fiber in the achievement of its optimum use in yarns, fabrics, blends with other fibers, mechanical processes, dyeing and finishing, and finally selection of end uses for maximum consumer satisfaction. In this first year of the commercialization of Arnel we have tried to provide a sound basis for processing this fiber on standard and available equipment.

This paper will concern itself with the present state of knowledge of the dyeing and finishing properties of Arnel, the new Celanese cellulose triacetate fiber. Although cellulose triacetate was originally available as a fiber as long as 50 years ago, its manufacturing behavior and the difficulties encountered at that time in dyeing and finishing caused it to be overlooked until recently.

The problems encountered with the dyeing and stabilization of the several new hydrophobic fibers, such as nylon, Dacron* polyester fiber, and the acrylics, have led to the development of high-temperature dyeing, dyeing accelerants, and heat-treatment processes. The success of these processes has reduced the resistance to any departure from simple jig and winch dyeing and has paved the way for the development of practical processes for Arnel. An outline of those processes for 100% Arnel and Arnel-blended fabrics that are the responsibility of the dyehouses is given in Table I.

Yarn and fiber properties will be outlined, and a detailed discussion will be devoted to heat-treatment phenomena, since many of the important properties of Arnel fabrics are achieved as a result of heat treatment. An additional objective of this paper is to present the results of extensive research, as well as practical experience in commercial dyehouses achieved even before large quantities of Arnel-containing fabrics had been marketed. This prior experience confirms that no major processing problem should result from the handling of Arnel fabrics in existing dyehouse equipment.

F Fortess

Although the dyeing rate of Arnel cellulose triacetate with disperse (acetate) dyes is somewhat slower than that of the standard acetate, it can be dyed at temperatures close to the boil without fear of saponification or delustering. This means that dyeings in closed jigs and winches can be attained in normal dyeing times in light and medium shades. For very heavy shades, such as navy blues and blacks, dyeing accelerants will permit achievement of shades in commercial dyeing times and more economical use of dyes.

When fabrics dyed with selected disperse dyes have been given a heat treatment, good fastness to AATCC Wash Test No. 3 (160°F) is obtained. The light fastness of these disperse dyes on Arnel is similar to that on acetate, while the gas-fading resistance of heat-treated Arnel is, in general, slightly better.

Work in progress indicates that blends of Arnel with cotton, wool, rayon, and Dacron can be dyed satisfactorily. Good blacks can be attained on straight Arnel with developed azo dyes. A wide variety of nondurable as well as a number of durable finishes have been successfully applied on Arnel and Arnel-blended fabrics.

TABLE I

DYEHOUSE PROCESSES FOR ARNEL AND ARNEL-BLENDED FABRICS

1) Singeing, boiloff and scouring
2) Bleaching procedures
3) Basic dyeing properties
4) Dyeing in the jig and winch
5) Dyeing under pressure or with accelerants
6) Selection of dyes, inhibitors and procedures for the achievement of optimum color-fastness properties
7) Chemical finishing
8) Heat-treatment processes and effects
9) Special problems in the dyeing and finishing of blends
10) Fabric properties achieved

GENERAL PROPERTIES OF ARNEL CONTINUOUS-FILAMENT YARN AND STAPLE FIBER———It has become increasingly evident to the textile industry that the intrinsic properties of a fiber must be taken into consideration in planning its optimum processing, as well as the achievement of the best end uses. Thus the strength, elongation, elastic modulus, moisture regain, wet and dry properties and specific gravity must be known. A useful list of these properties is presented in Table II.

The fact that Arnel at standard conditions has the same strength characteristics as dry secondary cellulose acetate must be

TABLE II

PHYSICAL PROPERTIES OF ARNEL TRIACETATE

Tenacity, gpd, standard conditions*	1.2-1.4
Tenacity, grams per denier (gpd), wet	0.8-1.0
Knot tenacity, gpd, standard conditions	1.0-1.2
Loop tenacity, gpd, standard conditions	1.0-1.2
Percent elongation, standard conditions	22-28
Percent elongation, wet	30-40
Modulus of elasticity, gpd	44
Specific gravity (H_2O at 25°C/25°C)	1.33
Standard moisture regain	3.2%
Water absorptivity (100% RH, centrifuging method, heat-treated Arnel)	10-11%
Area swelling**	
Not heat-treated	4.0%
Heat-treated	1.5%

* 65% RH, 70°F.
** Determined by immersion in water at 72°F from an initial conditioning at 65° RH, 72°F. Generally, comparative data for other fibers are as follows:

Acetate	6-8%
Wool	25%
Cotton	40-42%
Reg ten viscose rayon	65%

* Registered trade-mark.

† Presented at Kohler's Swiss Chalet in Rochelle Park, New Jersey, on Friday evening, April 22, 1955.

considered in designing fabric constructions and weights. The retention of strength characteristics under hot, wet conditions and the lower moisture regain can be exploited in the development of washable fast-drying fabrics. As will be noted later in this paper, many of the properties, particularly those related to the thermoplastic character of cellulose triacetate, are significantly improved by treatment at elevated temperatures. The heat-treatment process must be considered essential for the achievement of those properties related to washability, wrinkle performance, dimensional stability and general appearance.

GENERAL WET PROCESSING

GREIGE-FABRIC PREPARATION ——A major function of the scouring of Arnel fabrics is the removal of all foreign materials, which may discolor or become reactive in the subsequent heat treatment. In this connection, it must be mentioned that Celanese is using easily scourable lubricants for its yarn and staple. In addition, current sizing recommendations, which have been successfully employed in extensive weaving trials, involve easily scourable sizing materials. For continuous-filament yarns polyvinyl alcohol and the sodium salt of styrene-maleic anhydride copolymer have been successfully employed. Spun yarns are being sized with starch ether-polyvinyl alcohol formulations with overwaxing to improve loom efficiency. Both the lubricants and the indicated sizes are easily removed by any of the standard scour-bath formulations currently being used, including soaps, sulfonated and sulfated oils, nonionic detergents, and alkylarylsulfonates. Where metallic stains and grease spots are present, the use of solvent scouring and oxalic acid or acid fluoride treatment can be employed with no measurable harmful effect on Arnel.

A typical procedure for a spun fabric involves

1) Singeing—no melt balls have been noted.

2) Hinneken boiloff at maximum temperature—200-212°F—to help stabilize spun fabrics and minimize creasing and cracking.

3) 30-minute scour at 160° F in a detergent bath containing 1-2g detergent per liter and some tetrasodium pyrophosphate or other water softener.

A typical greige spun fabric will contain 2-3% ether extractables and 4-7% water extractables. After a scour of this type the ether extractables will be reduced 0.2-0.3% and the water extractables, 0.3-0.4%. Subsequent dyeing will usually reduce the amount of residual material if sufficient rinsing is practiced.

It should be noted that Arnel fabrics do not stretch or shrink so much as acetate under these hot, wet conditions. In addition, Arnel fabrics are more resistant to saponification under long scouring and dyeing procedures. Table III contains the effect of a simulated scouring in a closed jig for 16 hours at 203° F (95° C) at a pH of 9.5. Under these conditions no delustering and only 1.5% stretch were observed. In addition, there was no detectable change in pH throughout this long treatment, and no apparent chemical change in the fiber was observed.

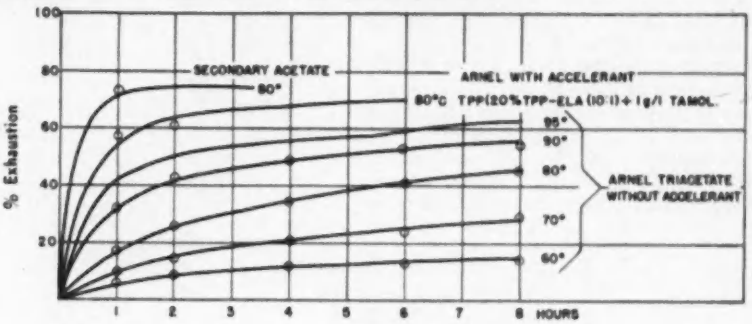


Figure 1

Dyeing rate of secondary acetate and triacetate with 2% Eastone Red GLF owf and 2 g/l Tamol in a 1:50 liquor ratio

TABLE III

EFFECT OF SCOURING AND DYEING* IN COVERED JIG AT 203°F (95°C) AND pH 9.5

	Original	*After 16 hours*
pH of bath	9.5±0.2	9.5±0.2
Luster	bright	no delustering
Moire		none
Percent stretch (warp)		1.5%
Loss of combined acetic acid		< 0.1%
Loss in intrinsic viscosity		< 0.1

* Bright Arnel sharkskin prepared from 150/2/40 yarn

BLEACHING PROCEDURES——Arnel triacetate yarn and fiber can be produced with a high level of whiteness. However, under autoclaving and dry-heat-treatment conditions, residual lubricant, size, scouring and dyebath components, and improper finishing agents may yellow or discolor. To achieve the best finished whites, bleaching procedures may be applied after a scouring step and removal of metallic stains with oxalic acid or acid fluoride.

A wide variety of bleaching formulations have been evaluated on Arnel. These include alkaline and acid hypochlorite, Textone, peracetic acid, and combinations of a number of these with each other and with hydrogen peroxide. In no instance where proper precautions of pH and temperature control are employed, and where residual bleaching agent was removed from the fabric before drying, was a significant reduction in physical properties (tear, abrasion and tensile) noted. Where blends with cotton, wool, or nylon, etc, are processed, the bleaching procedure must be selected for optimum results on the other fiber being blended with Arnel.

Frequently it is desirable for the achievement of optimum whites to scour, finish and heat-treat, and finally to bleach in order to remove the slight yellowing that may occur on heat treatment. This wet processing after heat treatment also serves to stabilize the hand of the fabric. In instances where yellowing does occur, a light scour after heat treatment will usually reduce the discoloration sufficiently that tinting with a washfast blue or violet will produce a satisfactory white.

A typical set of optical data on scoured, heat-treated and bleached fabrics as obtained by the Hunter Color Difference Meter for *L* (whiteness), and *b* (yellowness) is recorded in Table IV.

TABLE IV

EFFECT OF A BLEACHING AFTER HEAT TREATMENT ON THE WHITENESS AND YELLOWNESS OF SCOURED AND UNSCOURED ARNEL FABRIC

	Whiteness L-Reading		*Yellowness b-Reading*	
	*No Scour**	*Scoured*	*No Scour*	*Scoured*
Not bleached	79.8	81.1	+2.8	+2.5
Textone + acetic acid	82.0	93.3	+4.1	+1.4
Calcium hypochlorite	82.8	94.5	+2.1	+1.1
Peracetic acid + caustic	82.1	94.3	+1.6	+1.0

* All samples were heat-treated at 430°F before bleaching.

DYEING PROPERTIES OF ARNEL ——A major deterrent to the commercialization of cellulose triacetate has been its relatively slow dyeing rate in comparison with acetate. This is illustrated by the curves in Figure 1. Normally, secondary acetate is dyed in a range of 158-176° F (70-80° C), and during the last 25 years a wide variety of disperse dyes have been developed which give a good pile-on on secondary acetate in as little as two hours dyeing time. Under these same conditions Arnel dyes at less than half the rate.

Experience with Dacron during the last five years has led to the development of closed jigs and winches in dyehouses pro-

cessing synthetic fibers, the use of dyeing accelerants, and the development of pressure-dyeing facilities. At 205° F (96° C) in a closed jig or winch, commercial shades up to medium and heavy can be attained on Arnel in eight hours time with many of the selected dyes to be described. The use of accelerants specifically developed for Arnel further increases the dyeing rate, so that navies and blacks can be achieved with disperse dyes in four to six hours at 205° F (96° C) in the presence of an accelerant. This is perhaps more dramatically illustrated by the curves containing data on samples prepared in bucket dyeings at 167° F (75° C), and at 205° F (96° C) with accelerant. The percent of exhaustion of dye taken from samples at one to eight hours is recorded in Figures 2 and 3.

The critical effect of fabric-to-liquor ratio upon dye takeup in the absence or presence of dyeing accelerant is illustrated in Figure 4. It should be noted that the accelerant has a significant effect on the one-hour dye absorption in the 1:5 to 1:20 range of liquor ratios under covered jig and winch conditions. At a 1:5 liquor ratio, 80% of the Eastone Red GLF is absorbed by the fiber in one hour at 185° F (85° C) when tripropyl phosphate is used.

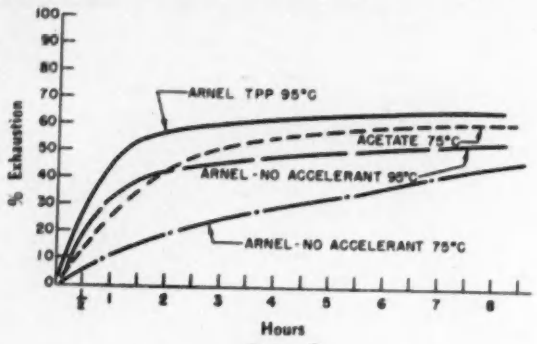


Figure 2

Comparative dyeing rates on acetate and Arnel, of 3% Lenra Blue RLS

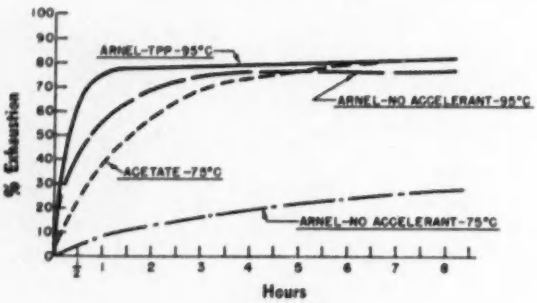


Figure 3

Comparative dyeing rates on acetate and Arnel, of 3% Eastone Fast Red GLF

THE USE OF ACCELERANTS——It is apparent that Arnel does not display the initial strike characteristics of acetate and rayon at 167-176° F (75-80° C), and therefore does not produce the leveling problems experienced with these more rapid-dyeing fibers. The mechanism of the accelerant action in the dyeing of Arnel has been given intensive study. For the purpose of this presentation we will use the term *accelerant* rather than *carrier*, since the primary objective of the use of this class of dyeing assistants is to accelerate the rate of dyeing to give optimum depth of shade, maximum penetration into fiber, and optimum level of fastness properties. It has been noted that certain of these dyeing assistants actually absorb into the fiber and change the capacity of the fiber for dye as well as increase the rate of diffusion of dye into the fiber. This increase in percent exhaustion at equilibrium in the presence of dyeing assistants will be critically examined with the objective of more exactly describing the phenomenon as accelerant action or some other suitable terminology. It has been found that all of the accelerants developed for Dacron are also effective on Arnel; however, a wide variety of organic liquids have been found that are effective on Arnel but not on Dacron. Table V illustrates this observation.

Although we have listed several Arnel accelerants in Table V, we will use tripropyl phosphate to illustrate the mechanism of accelerant action and the desired properties produced. Tripropyl phosphate is an excellent solvent for most of the high-melting, high-temperature-dyeing disperse dyes. For example, Lenra Yellow CW is 33% soluble in tripropyl phosphate at room temperature. When used at 10% on the weight of the fabric in a dyebath, the solubilizing action of this accelerant on the dye is noted by the increased depth and brightness of the liquor color. The Arnel fabric dyed in the presence of 10% tripropyl phosphate will absorb 2-3% accelerant owf (on weight of fiber). Although this is not removed by a

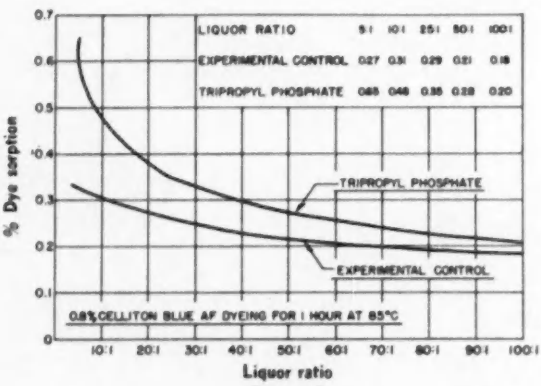

LIQUOR RATIO 5:1 10:1 25:1 50:1 100:1
EXPERIMENTAL CONTROL 027 031 029 021 018
TRIPROPYL PHOSPHATE 068 048 035 028 020
% Dye sorption
TRIPROPYL PHOSPHATE
EXPERIMENTAL CONTROL
0.8% CELLITON BLUE AF DYEING FOR 1 HOUR AT 85°C
Liquor ratio

Figure 4

The effect of fabric-to-liquor ratios on dyeing rate

TABLE V

ACCELERANTS

For Arnel
tripropyl phosphate
tributyl phosphate
diethyl phthalate
pine-oil alcohols
triethyl citrate

For Arnel and Dacron
orthophenylphenol
trichlorobenzene
biphenyl
methyl salicylate
benzoic acid

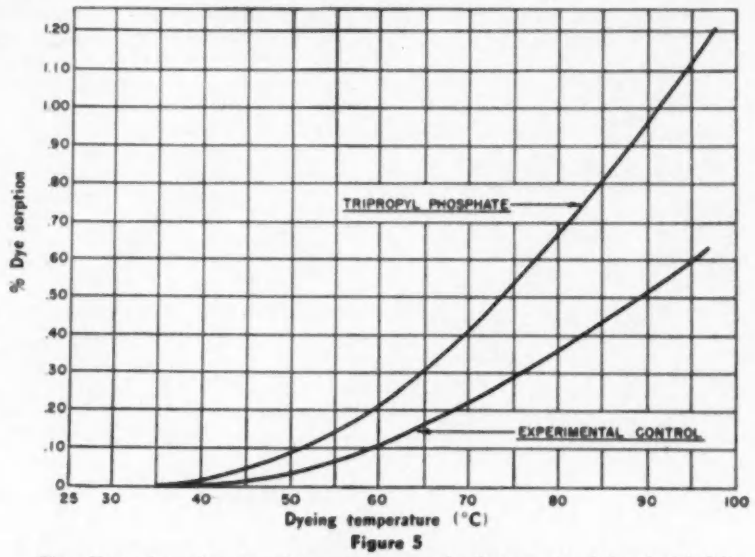


Figure 5

The effect of accelerant and temperature on the dyeing rate of Arnel with 2% Eastone Red GLF, 1-hour dyeing

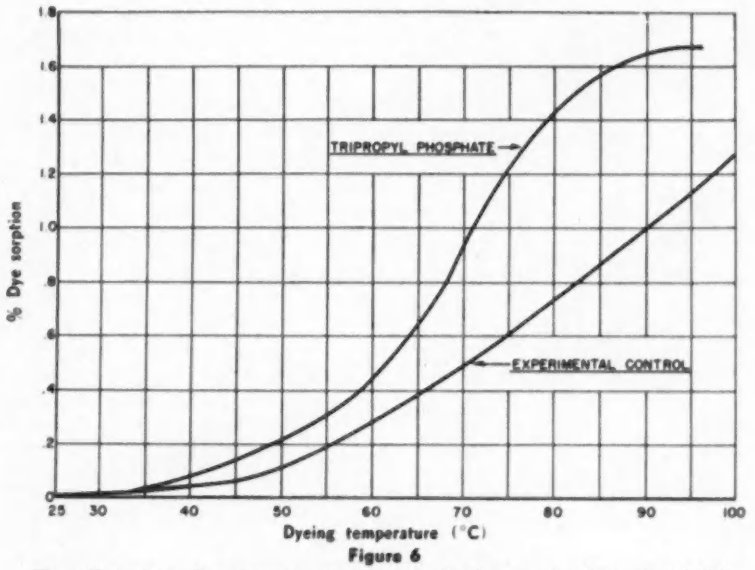


Figure 6

The effect of accelerant and temperature on the dyeing rate of Arnel with 2% Eastone Red GLF in an 8-hour dyeing

quick soaping, which indicates it has penetrated, most of the tripropyl phosphate may be removed by a fresh rinsing, especially if an effective nonionic emulsifying agent is used in the wash.

These observations suggest that tripropyl phosphate acts as an accelerant for dyeing Arnel with disperse dyes by

1) Solubilization of crystalline dyes in the aqueous phase.

2) Adsorption onto the fiber surface providing a dye solvent at the fiber-liquor interface.

3) Absorption into the fiber, swelling the fiber and weakening molecular bonds, permitting easier access for dye diffusion into the fiber.

The effect of tripropyl phosphate on dyeing rate as a function of temperature and time is illustrated in Figures 5 and 6.

To illustrate the effect of accelerant on dye penetration, cross sections have been selected from nonaccelerant and accelerant dyeings with Eastone Red GLF. The effect of heat treatment on further diffusion is also noted in Figures 7 and 8.

TABLE VI

EFFECT OF DYEING ACCELERANT IN JIG OR WINCH

1) Produces more balanced dyeing, since azo, diphenylamine and anthraquinone dyes are all accelerated.
2) Permits earlier addition of dye for shade matching, thus permitting dyeing of disperse navies and blacks in 5-6 hours.
3) Increases penetration of dye into fiber, permitting achievement of optimum washfastness.
4) Permits use of less dye and results in greater percent dye exhaustion in commercial times.
5) Provides better control of initial dyeing rate or strike, thereby minimizing leveling difficulties.

A sufficient number of plant dyeing trials have been run with accelerants on self shades and mixed recipes to justify the summary in Table VI. In the selection of particular dyeing accelerants, such factors as effectiveness, cost, chemical effect on dye, toxicity, unpleasant odor, degradative effect on fiber, ease of removal from fiber, and stability in the dyebath must be considered.

SELECTION OF DYES FOR DYEING ARNEL——During the past five years the Research Laboratories of the Celanese Corporation of America have made an intensive investigation of the fastness properties of available disperse (acetate) dyes. A summary of this work with particular emphasis on washfastness was published in the paper, "Improved Washfastness of Acetate-Rayon Blends." (*1*). Many of these same dyes, properly applied to Arnel, show improved washfastness when compared with secondary acetate. A further improvement in washfastness is noted on heat treatment.

The list of dyes tabulated in Table VII is sufficient to illustrate the basis for achieving fastness to AATCC Wash Test No. 3 (160° F) in a wide range of shades for absence of staining as well as for washdown. They have been selected for

1) Dyebath stability at the recommended dyeing temperatures of 205° F (96° C) or higher.

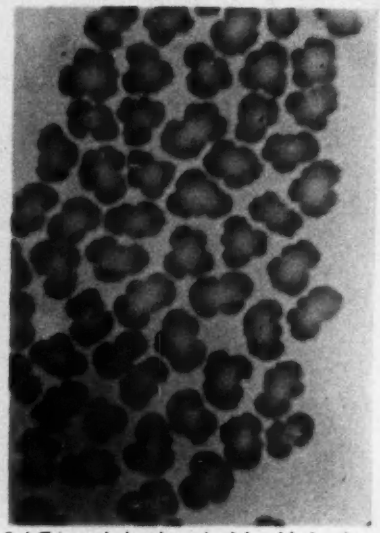
2) Minimum sublimation in the heat-treatment processes for Arnel.

3) Practical level of exhaustion rate and pile-on.

4) Intrinsically high washfastness.

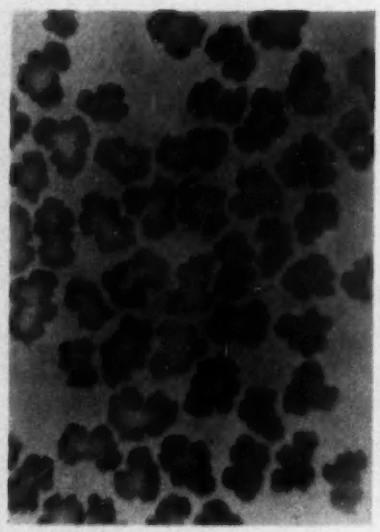
In selecting the dyes, the relatively high fastness properties with respect to gas fading, "O-Fading" (pronounced Oh-Fading), light fastness, wet bleeding and sublimation have been considered in connection with the depth of shade and the intended end use. Where blue dyes of good pile-on but decreased gas fastness are used, inhibitors must be codyed for protection. The effect of inhibitor on yellowing and decreased light fastness of dye must be taken into account, primarily for very light shades. For special shades, such as bright reds, a dye may be required which has only intermediate light fastness, so that end use of the fabric must be considered.

1-A Control before heat treatment

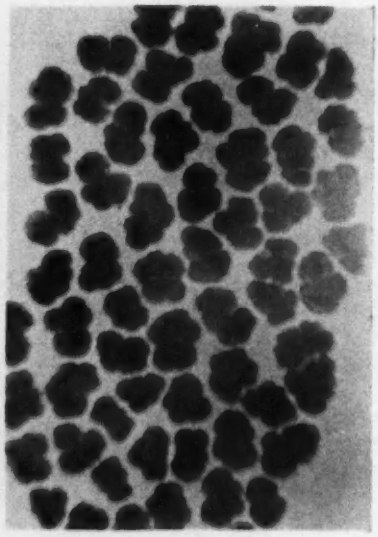


2-A Tripropyl phosphate-dyed Arnel before heat treatment

Figure 7



1-B Control after heat treatment



2-B Same after heat treatment

Figure 8

Effect of accelerant and heat treatment on Eastone Red GLF distribution in Arnel

The dyestuff manufacturers are aware of the principles outlined for dyeing Arnel and have co-operated wholeheartedly in making available special dyes, including experimental structures, for evaluation on Arnel. Improved dyes, and in some cases more economical products, have been added to the list each week. For many shades the dyeing cost is the same on Arnel as for these same dyes on acetate. However, since the best washfast anthraquinone blues are in the $6-$7/lb class, they add significantly to the dyeing cost of Arnel in comparison with acetate, as the latter is seldom dyed a navy shade with a washfast, expensive blue dyestuff. The dyeing costs of Arnel compare favorably with those of the polyester and acrylic fibers, and the same colorfast performance can be achieved.

JIG- AND WINCH-DYEING PROCEDURES FOR ARNEL——Many thousands of yards of continuous-filament and spun-Arnel fabrics of a wide range of weights and constructions have been dyed under commercial conditions by the principles outlined in Table VIII.

Arnel fabrics display less swelling, shrinkage and distortion in dyeing than do acetate and rayon. In the jig this has resulted in much less stretching of the fabric, less difficulty with moiré-glazed patterns, no delustering of bright-yarn fabrics, and a minimum of shaded selvedges in tightly woven, heavy sharkskins. Because Arnel swells so little, if at all, a somewhat longer time is required to set the fabric to the jig to minimize creasing and loose selvedges. In the winch the more loosely woven spun fabrics do not tend to shrink up, and cracks and dye creases may become a source of difficulty. However, proper selection of dyes and dyebath components to improve the dispersion and mechanical changes in reel design and position have minimized this problem.

COLOR FASTNESS PROPERTIES ACHIEVED ON ARNEL

Although the nature of the heat-treatment process and the various effects on the Arnel fabrics are to be discussed later, the evaluation for color-fastness properties must be carried out on finished and heat-treated fabrics. This is justified, since it is recognized that all or most Arnel-containing fabrics will be heat-treated to enhance a variety of properties, among which washfastness, and resistance to gas and "O-Fading" are of particular interest to the dyer. In heat treatment many shades are deepened slightly because of the redistribution of dye away from the periphery. In addition, small changes in hue may result from the discoloration of inhibitor, finish, and impurities on the surface, or from optical effects due to smoothing of yarn surfaces at elevated temperatures. A wash after heat treatment frequently produces a slight shade change without removal of dye, and this must be taken into account in evaluating washfastness.

WASHFASTNESS —— The previous discussion emphasized the proper selection of dyes and the optimum conditions of dyeing for the achievement of washfastness. The treatment of Arnel fabrics at temperatures up to 425-450° F significantly improves washfastness, particularly with respect to the staining of nylon and acetate in the multifiber test cloth in the AATCC Wash Test No. 3 (160° F). This is due in large part to the diffusion of dye further into the fiber as illustrated by the cross sections contained in Figures 7 and 8. In addition, heat treatment modifies the molecular structure of the fiber in such a manner as to decrease the diffusion of dye under normal washing conditions. This is noted in the drastic reduction in rate of dyeing of heat-treated fabrics illustrated in Figure 9.

Fabrics have been prepared under commercial conditions in a full range of shades up to navies which pass the AATCC Wash Test No. 3 for shade change, color in the wash liquor, and staining of whites on repeated washes. A typical 4.5% dyeing of

TABLE VII
SELECTED DISPERSE DYESTUFFS FOR ARNEL

AATCC Test Ratings
*AATCC Wash Test No. 3 (160°F)**

Dyestuff	*Sublimation**	*Shade Change*	*Staining Nylon*	*Staining Acetate*	*Bath Color*	*Gas Fading** 1 Unit*	*Gas Fading** 2 Units*	*Light Fastness** 20 Hr*	*Light Fastness** 40 Hr*	*"O-Fading"** 2 Units****
Eastman Blue GLF	4-5	4-5	5	5	practically none	4-5	4	4-5	4	2
Lenra Blue RLS	4	4-5	5	5	pn	4-5	4	4-5	4	2
†Interchem Blue GSF	4-5	4-5	4	5	pn	4-5	4	4-5	4	2
Cibacete Blue GLF	4-5	4-5	4	5	pn	4-5	4	4-5	4	2
Latyl Blue FL	4-5	4-5	4	5	pn	4-5	4	4-5	4	2
Celliton Blue LAFR	4-5	4-5	5	5	pn	4-5	4	5	4	2
Nacelan Blue KLF	4	4-5	4	5	light	5	4-5	4-5	4	2
Latyl Blue BG	5	5	5	5	light	5	4-5	5	4-5	2
Eastone Red GLF	4-5	4	4	4	light	5	5	4-5	4	5
†Interchem Red GSF	4-5	4	4	4	light	5	5	4	3-4	4-5
†Interchem Scarlet GSF	4-5	4	4	4	light	5	5	4	3	4
Celliton Red GGLL	4	4	4	4	light	5	5	4-5	4	5
Eastone Fast Red 2BGLF	4	4	4	3-4	light	5	5	4	3	4-5
Eastone Fast Pink 3BGLF	4-5	4	4-5	4-5	light	4-5	4-5	4	3	4-5
Cibacete Red GGF	4	4	4	3-4	light	5	5	4-5	4	5
Celliton Fast Red 6DAC	4	4	5	5	pn	5	5	4-5	4-5	2
Celanthrene Violet BGF	4	4	5	4	pn	4-5	4	4-5	4	2
Eastman Violet 3RGLF	4	4	5	4	pn	4-5	4-5	4-5	4	2
Nacelan Red 2G	4-5	4	4	4	pn	5	5	4-5	4	5
Lenra Yellow CW	4-5	4-5	4-5	4-5	light	5	5	5	4-5	5
†Interchem Yellow HDLF-40	4-5	4-5	4-5	4-5	light	5	5	5	4-5	5
Celliton Fast Yellow GGLL	4-5	4	4-5	4	light	5	5	5	4-5	5
Latyl Yellow YL	4-5	4-5	5	5	light	4-5	4-5	4-5	4-5	5
Eastone Fast Yellow 2RGLF	4	4-5	5	3-4	pn	4-5	4-5	4-5	3-4	5
Artisil Yellow RCGFL	4-5	4	5	4	light	4-5	4-5	4-5	4	5
Cibacete Yellow GWN	4-5	4	5	4	pn	4-5	4-5	4-5	4	5
Nacelan Fast Yellow KAL	4-5	4	5	4	pn	4-5	4-5	4-5	4	5

† Now called Interchem *Triacetate* Blue, etc.
* 3% dyeing
** 0.5% dyeing
*** Two units of exposure to "O-Fading" is exposure for 2 16-hour periods in the gas-fading cabinet of the US Testing Co in which the gas flame is replaced by Westinghouse or General Electric home-deodorizer (ozone) lamps.

a dark brown resulted in the quantitative color loss shown in Table IX.

A fabric that had been dyed but not heat-treated displayed progressive shade loss and excessive staining, whereas a corresponding dyed and heat-treated sample was rated on the International Grey Scale as 4 for shade change on the first wash, with no further change on the second and third wash. The staining was slight on the first wash and none showed on the second and third wash. This same fabric washed ten times on an agitator-type automatic home washing machine at 140° F was rated 4 for change of shade.

To reduce staining in the washing of heavy shades, especially navies, the use of 1 gram per liter of sodium hydrosulfite in a scour, either after dyeing or after heat treatment, serves to strip off surface dye. The shade change is negligible, indicating that only a very small quantity of surface dye is removed.

GAS FADING———The effect of nitrogen dioxide in the atmosphere upon dyed secondary acetate fabrics has been given appreciable attention during the past decade with the recent development of resistant blue dye structures and inhibitors. Dyed and heat-treated Arnel fabrics display about the same level of resistance to atmospheric gas fading as does secondary acetate. It should be noted that heat treatment results in a small but significant improvement in resistance to gas fading, due primarily to the redistribution of dye away from the outer surface.

The use of selected gas-fast dyes, in the absence of inhibitor, will provide 3-4 units of resistance for all but the most sensitive shades. Where the shade requires the use of less-resistant dyes, the use of codyeing inhibitors provides a practical level of protection. A major problem still exists, since even the best inhibitors tend to yellow during exposure, producing a greening of the shade, which, in the case of light blue and grey hues, is almost as undesirable as the

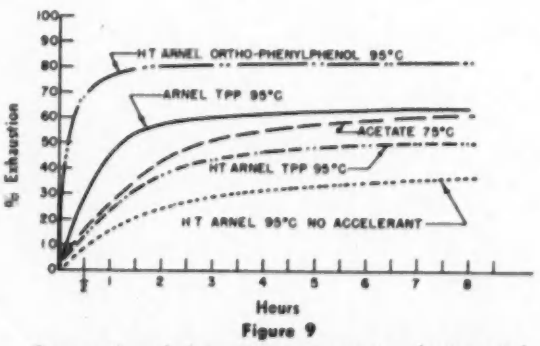


Figure 9
Comparative dyeing rates on acetate, heat-treated Arnel, and nonheat-treated Arnel for 3% Lenra Blue RLS

TABLE VIII
FACTORS INFLUENCING ACHIEVEMENT OF OPTIMUM JIG AND WINCH DYEING OF ARNEL

1) Proper dispersion of dyes; minimum number of dye-crystal aggregates.
2) Balance recipes or use of accelerant for heavy shades to shorten time of dye absorption after addition for shade matching.
3) Selection of dye preparations and dyebath assistants with maximum chemical and physical stability at elevated temperatures.
4) Use of maximum temperature of 205-212°F (96-100°C) in bath and atmosphere.
5) Use of minimum liquor ratios to increase dyeing rate and degree of exhaustion.
6) Use of minimum quantity of dye for achievement of shade and dyeing for sufficiently long time to permit penetration of dye beyond the surface.
7) Good scour after dyeing to remove loose surface and near-surface dye.

TABLE IX
LOSS OF DYE ON REPEATED AATCC WASH TEST NO. 3

Dark Brown	*Number of AATCC Wash Tests No. 3*	*Percent Dye Lost Yellow*	*Red*	*Blue*
Not heat-treated	1	26	29	24
	2	12	11	17
Heat-treated	1	4	2	10
	2	2	0	0
	3	0	0	0

TABLE X

COLOR FASTNESS ACHIEVED UNDER OPTIMUM PLANT CONDITIONS

Shade	Recipe	AATCC Wash Test No. 3 Shade Change*	AATCC Wash Test No. 3 Staining Nylon	AATCC Wash Test No. 3 Staining Acetate**	Gas Fading 3 Units Shade Change*	Fade-Ometer 40 Hours Shade Change*	Osonisor†
906 Spring Navy	Celliton Blue FFG Celanthrene Violet BGF Eastone Red GLF Interchem Yellow HDLF40 Conco Inhibitor FR	4-5	4	5	4-5	4	5
1484 Charcoal Grey	Lenra Blue RLS Eastone Red GLF Necelan Fast Yellow KAL Celanthrene Violet BGF Permalene AF	4-5	4	5	4-5	4	4
465 Hunter Green	Cellitan Blue FFG Lenra Yellow CW Eastone Red GLF Conco Inhibitor FR	4-5	4	5	4-5	4	5
530 Real Rose	Eastone Red GLF Interchem Blue GSF Lenra Yellow CW Conco Inhibitor FR	5	5	5	5	3-4	4
2067 Blonde Beige	Latyl Yellow YL Latyl Blue FL Eastone Red GLF Permalene AF	5	5	5	5	3-4	4
Light Blue	Eastman Blue GLF Interchem Yellow HDLF40	5	4-5	5	5	4	2

* Rated on International Grey Scale: 5 = no change, 4 = slight change, 3 = moderate change, 2 = marked change, 1 = severe change.
** 5 = no staining, 4 = slight staining, 3 = moderate staining, 2 = marked staining, 1 = heavy staining.
† Laboratory unit for producing constant concentration of ozone is described in Table VII.

reddening of a gas-sensitive shade. An intensive program is under way for the development of improved nonyellowing inhibitors.

To minimize yellowing effects, it is recommended that only 0.75-1.0% of inhibitor be used on pastel and light shades, 1-2% on medium shades, and 2-3% on heavy shades.

"O-FADING"———In the course of extensive service trials with dyed secondary-acetate drapery fabrics, it was discovered that shade changes occurred in these fabrics which could not be accounted for by the typical gas fading due to nitrogen dioxide. In Ames, Iowa, the standard AATCC gas-fading test strip and delicate shades on acetate dyed with Class B gas-fast blues and codyed with inhibitor showed no reddening because of gas fading. However, the same shade dyed with the best gas-fast blues without inhibitor displayed *marked reduction in depth* after prolonged exposure under identical conditions. Intensive investigation in the Celanese Laboratories and subsequent service trials revealed that heat-treated Arnel and Dacron dyed in the absence of accelerant display the same reduction in shade, though to a somewhat lesser degree, as secondary acetate. Before heat treatment, the uninhibited Arnel showed greater susceptibility to this anomalous fading than secondary acetate. Apparently the heat treatment improved resistance by inward diffusion of dye.

In the laboratory all of the blue dyes subjected to low concentration of ozone, in the absence of gas-fading inhibitors, displayed this bleaching, or reduction of depth. However, this effect appears to be of primary importance only for the light shades of grey, tan and blue. The use of approximately half the normal amount of typical gas-fading inhibitor is sufficient to minimize the bleaching effect of ozone on the gas-fast blue dyes.

This phenomenon of atmospheric fading by active components in the air other than nitrogen dioxide will be described in some detail in a paper by V S Salvin and R A Walker (3). For the time being we propose to refer to this phenomenon as "O-Fading", since effects similar to the service conditions can be achieved by exposure to ozone.

LIGHT FASTNESS———All our work to date indicates that the light fastness of disperse dyes is the same on Arnel as on secondary acetate. Most of the dyes listed in Table VII provide the basis for achieving a wide range of shades with satisfactory performance at 40 hours' exposure in the AATCC Fade-Ometer test. The usual precautions must be taken to avoid excessive use of inhibitors or finishing materials that are known to reduce light fastness.

SUBLIMATION———The principal sublimation requirement of the selected dyes is that they suffer no loss of color or change of shade during the heat-treatment process. In the laboratory this property is checked on fabrics that have only been dyed by enveloping the sample in a scoured Arnel fabric and subjecting this to a hot iron at the cotton-setting temperature of 428-446° F (220-230° C) for 30 seconds. Most of the dyes in Table VII have been evaluated under plant heat-treatment conditions and are satisfactory in shade change from loss of color.

DRYCLEANING ——— Arnel fabrics dyed according to the outlined procedures for achieving optimum washfastness give completely satisfactory drycleaning properties with all of the standard solvents, such as Stoddard solvent and perchloroethylene. Trichloroethylene, which is not ordinarily used in the United States, swells Arnel slightly and does extract dye from the fiber and is therefore not recommended for drycleaning.

Table X gives a summary of the color-fastness ratings to washing, light, and gas fading of a series of Arnel fabrics dyed and finished by the best procedures.

ADDITIONAL PROCESSES INVOLVING COLOR

DEVELOPED AZOIC BLACK———No color range is complete without a black, and satisfactory shades have been achieved on Arnel with selected disperse dyes. Developed blacks have also been investigated, and, although apparently good black shades can be achieved, on heat treatment at 450° F, many of the blacks become bronzy and sublime yellow to orange because of incomplete coupling. The developed black dyeing is a complex process involving three diffusions into the fiber: 1) a base, 2) the developer, and 3) the nitrous acid; and involving two chemical reactions: 1) diazotization of the base, and 2) coupling of the diazotized base and the developer.

It should be emphasized that the dyeing of Arnel with azoics differs from that of secondary acetate in three respects:

1) Slower rate of diazotization.

2) Betahydroxynaphthoic acid (BONA) absorption is more difficult because of an

TABLE XI
OUTLINE OF PROCEDURE FOR DEVELOPED BLACK ON ARNEL

1) Basing fabric for 4 hours at 205°F (96°C) with a diazo base, followed by a rinse.
2) Impregnation with BONA in fresh bath at pH 3.5-4 for 1 hour at 176°F (80°C), followed by light acidified rinse.
3) Diazotization for 1 hour at 77°F (25°C) with HCl-acidified sodium nitrite.
4) Rinse in cold water.
5) Development for ½ hour at 140°F (60°C) in H_2O buffered with sodium acetate, followed by a heat treatment for 1 hour at 194°F (90°C).
6) A clearing after the heat treatment to brighten the shade and minimize bronzing; a light sodium hydrosulfite strip is sufficient.

unfavorable fiber-to-bath equilibrium.

3) The required heat treatment causes sublimation of diazotized and uncoupled base and of developer.

In spite of these differences, a number of processes have been developed, which, in plant trials, have produced satisfactory blacks for shade and fastness properties. One procedure is illustrated in Table XI.

The fastness properties of developed blacks prepared by this process are included in Table XII.

STRIPPING AND REDYEING DYED ARNEL——In commercial practice a small but economically important percentage of fabrics must be redyed, either because of 1) streaking or poor dyeing, or 2) outmoding of shades. Since most of these fabrics will have been heat-treated, they cannot be redyed by the procedures previously outlined.

Where stripping of a heavy shade is required to dye a light or medium shade, zinc formaldehydesulfoxylate at pH 3-4 may be employed for stripping azoic and diphenylamine dyes. Textone, acidified with oxalic acid, can be used where anthraquinone blues have been included in the previous recipe. In most cases the fabric becomes yellow or light orange, and this residual color is poor in light fastness. These stripped, heat-treated fabrics may be dyed in the jig or winch at 205° F (96° C) in the presence of orthophenylphenol as the accelerant. This is illustrated in Figure 9, where a heat-treated fabric was dyed heavy shades.

If pressurized dyeing equipment, such as the Barotor, the pressure jig, or the Burlington Pressure Beam Dyer, is available, any shade can be achieved on heat-treated, dyed fabrics.

SCREEN- AND ROLLER-PRINTING 100% ARNEL WITH DISPERSE DYES ——A printing process has been worked out which gives commercially acceptable results with respect to color value, purity of hue, sharpness of design, levelness and color fastness The procedure is applicable to both roller and screen printing and can be carried out on existing equipment. The process does not require a special curing operation. The dye fixation is carried out simultaneously with the heat treatment. Practically all disperse dyes (regular and Latyls) are suited for the printing of Arnel by this process. Disperse dyes exhibit the same color fastness on Arnel whether the coloration has been obtained by printing or dyeing.

The relatively high temperatures (428-455° F or 220-235° C on fiber surface) needed for dye fixation require the use of thickeners which do not cause discoloration and scour easily even when severely dehydrated. Good results have been obtained with sodium alginate and modified locust bean gums; as British gum and Superclear formulations scour poorly, they are not recommended.

Color value, appearance, color fastness and reproducibility of a print depend largely on the type and amount of printing assistant used in the printing paste. The addition of 6-8% of phenyl Cellosolve or phenylmethylcarbinol to the paste has produced excellent results. The optimum printing-assistant concentration depends on the type of dye rather than on the dye concentration. Triethyl phosphate, tripropyl phosphate, propylene carbonate, butyl Cellosolve and benzyl alcohol have not been found useful as printing assistants.

Good protection from gas fading is obtained by the addition of 2% Anti-Fume DEN to the printing paste. While this inhibitor reduces azo dyes in regular dyeing, it has no undesirable effects whatsoever on the outcome of the prints.

A well-scoured fabric is a prerequisite for good printing results. Greige or insufficiently scoured goods have poor affinity for printing paste and therefore give prints of an unlevel appearance. Good scouring is also essential to avoid the fixation of foreign materials to the fabric during heat treatment.

Laboratory tests have shown that the printing process is also applicable for the printing of tricots which have been set by autoclaving. The process has not yet been tested for the printing of Arnel-Dacron and Arnel-nylon blends. The cost picture of the process can only be determined by large-scale trials.

The fastness properties of disperse dyes in printed areas are approximately the same as when applied on jig or winch. The fastness to AATCC Wash Test No. 3 (160° F) is reported for a number of shades in Table XIII.

TABLE XII
FASTNESS RATINGS OF DEVELOPED BLACKS ON ARNEL

Composition	AATCC Wash Test No. 3 Wash Fastness: Shade	Staining: Nylon	Staining: Acetate	Light: 20 hr	Light: 40 hr	Gas: 4 units	Sublimation
Setacyl Diazo Black B Betahydroxynaphthoic acid (BONA)	5	4-5	4-5	4-5	4-5	4-5	5
Eastman Diazo Black SN Betahydroxynaphthoic acid (BONA)	5	4-5	4-5	4-5	4	4-5	4-5

TABLE XIII
WASHFASTNESS OF PRINTED DISPERSE DYES ON ARNEL

Shade	Recipe	Ratings to AATCC Wash Test No. 3: 1st Wash: Shade	1st Wash: Staining: Nylon	1st Wash: Staining: Acetate	2nd Wash: Shade	2nd Wash: Staining: Nylon	2nd Wash: Staining: Acetate
Dark Grey	0.40% Eastone Blue GLF 0.12% Eastone Red GLF 0.20% Interchem Yellow HDLF40	4-5	4	5	4-5	5	5
Paris Green	0.50% Latyl Blue BG 1.50% Lenra Yellow CW	4	4	4	4	5	5
Brick Red	0.13% Eastman Blue GLF 0.70% Eastone Red GLF 0.175% Interchem Yellow HDLF40	4	3	4	4-5	4	5
Dark Brown	0.44% Eastman Blue GLF 0.61% Lenra Orange BL 0.07% Eastone Red GLF	4	4	4	4-5	4	5
Navy	4.00% Celliton Blue FFG 0.80% Eastone Red GLF 0.40% Interchem Yellow HDLF40	2-3	2	2	4	4	4

THE HEAT TREATMENT OF ARNEL FABRICS

It cannot be emphasized too strongly that the heat-treatment step is the most important process in the conversion of an Arnel fabric from the greige to the finished condition. Reiner G Stoll in a recent paper (3) described in some detail the heat-treatment phenomenon and its effect on fabric properties. Without heat treatment an Arnel fabric will, in general, display the following properties in comparison with acetate:

1) washfast at 10-20° F higher temperature

2) equal light fastness

3) poorer gas and "O-Fading" fastness

4) less moisture regain and somewhat faster drying properties

5) slightly better wrinkle performance

6) slightly better shrinkage resistance

7) slightly better glazing and ironing properties.

When an Arnel fabric is treated for 10-20 seconds in a substantially relaxed condition at temperatures of 428-464° F (220-240° C), all of the listed properties are significantly improved.

Although the effect of the heat treatment upon the internal structure of the triacetate fiber is not completely understood at this time, it is apparent that a basic modification in thermoplastic properties occurs. The three major effects of heat treatment on dyed Arnel fabrics are listed in Table XIV with their relationship to other properties. Unlike Dacron and nylon, Arnel does not shrink appreciably during heat treatment, and at the elevated temperature is somewhat plastic and easy to stretch and distort. This necessitates that the fabric be under minimum tension and turbulence of air currents during the heat treatment.

The various effects of the heat treatment are not simultaneous. Thus, at as low as 356° F (180° C) the washfastness and "O-Fading" begin to improve because of diffusion of dye inward. At 392° F (200° C) the fibers and yarns begin to relax, the safe ironing point is raised, and dimensional stability and wrinkle performance are improved. It is the resistance to hot-bed-press glazing that requires the maximum change in crystal size and order, and it is for this property that temperatures as high as 464° F (240 °C) must be attained in heat treatment.

In the absence of special finishes, most Arnel fabrics will show a reduction of 10-20% in tensile strength in processing on any of the hot-roll, hot-air, or radiant-heat units to be described.

Wet-pressure-treated fabrics achieve excellent dimensional stability, wrinkle performance and ironing properties. The staining properties of these fabrics in washing are inferior to those processed by dry heat treatment. However, the washfastness can be improved by subsequent dry heat treatment or hydrosulfite stripping. The hand of the autoclaved fabrics tends to be softer than that of the dry-heat-treated fabrics.

TABLE XIV
EFFECT OF HEAT TREATMENT ON FABRIC PROPERTIES

1) Increases size and/or perfection of crystallites.	1) Increases softening and sticking point, improving ironing and glazing resistance. 2) Decreases moisture regain and increases drying rate. 3) Reduces swelling and shrinkage.
2) Relaxes stress in fibers and yarns introduced in textile processing.	1) Improves dimensional stability. 2) Improves wrinkle performance.
3) Increases diffusion of dye from periphery into fiber.	1) Improves washfastness. 2) Improves gas-fading resistance. 3) Improves "O-Fading" resistance. 4) Improves crocking resistance.

TABLE XV
HEAT-TREATMENT CONDITIONS ON HOT-ROLL SYSTEMS

	6-Roll National Dryer		Morrison 2-Roll	
Fabric	Roll Temp, °F	Speed yd/min	Air Temp, °F	Time, seconds
Light filament	425	25	425	12
Heavy filament	440	25	450	14
Light spun	450	25	450	10
Heavy spun	450	20	450	15

HEAT-TREATMENT PROCESSES———Fortunately, a number of commercial processes already exist which provide the basis for achieving many of the desired properties on Arnel. Extensive trials indicate that most of these can produce the desired temperature ranges and therefore the improvement in thermoplastic properties. However, in each of these processes the fabric must be held or pulled, and this introduces mechanical effects that are undesirable and must be minimized.

HOT-ROLL SYSTEMS———Two commercially available hot-roll machines are the 6-roll National Dryer Co unit, in which each can is internally heated; and the 2-roll Morrison Machine Co unit, which is enclosed and heated with hot air. The 6-can unit contacts the fabric on both faces, whereas the 2-roll machine contacts only one face. In all hot-roll machines special attention must be taken to avoid warpwise tension on the hot fabric, since this will pull out yarn crimp, especially in spun-yarn fabrics. The operating temperatures and contact times vary with the fabric weight, and relatively low speeds are recommended to produce both the relaxation of strains as well as crystal growth. Some recommended conditions are given in Table XV.

Many variations of these two systems have been developed by individual companies, and with proper precautions most of these can be usefully applied to the heat treatment of Arnel fabrics.

RADIANT-HEAT PROCESSES———Extensive experience has been obtained with a 90-foot pin-frame drying unit, onto which top and bottom panels of Sill radiant-heat units have been attached at the exit end. Such a unit has been installed at the Hopewell, Virginia, Dyehouse of the Celanese Corporation and has provided the basis for processing the first hundred thousand yards of Arnel fabrics of every conceivable construction. The most important precautions to observe in a process of this type are to minimize the turbulence of air in both the drying and radiant-heating sections and to compensate for the cooling effect of the pins and rails at the selvedges. Both of these problems have been solved, so that less than 1% stretching occurs in the filling-wise direction because of sag and flapping, and less than 15° F variation occurs from selvedge to selvedge. This standard pin frame with a radiant-heating-unit attachment proves very versatile in that a wide range of fabric weights and constructions can be successfully processed.

HOT-AIR PIN AND CLIP FRAMES———A sufficiently large number of trials have been run with hot-air frames now being used to process nylon and Dacron fabrics. Whereas fabrics made from these two fibers tend to shrink and also to resist distortion by unbalanced air currents, Arnel fabrics, processed in the same equipment at higher air temperatures and therefore at greater air velocities, tend to be distorted and may stretch as much as 10% across the width.

The balancing of the air flow remains the major shortcoming of this heat-treatment principle. Clip marks represent an additional disadvantage. However, satisfactory heat-treatment conditions have been achieved on hot-air clip frames with continuous-filament fabrics, and further consideration can be given to this approach, especially where cotton and rayon are blended with Arnel, since these fibers prevent fabric stretching in heat treatment.

"WET" HEAT TREATMENT IN AUTOCLAVES AND PRESSURE-DYEING EQUIPMENT———Many of the properties imparted by dry heat, whether hot-air or radiant, also result from the treatment of Arnel fabrics on beams in steam-pressure autoclaves, pressure beam dyers, the Barotor pressure dyer, and in pressure jigs. The conditions range from 30 minutes to 2 hours at a pressure of 20-40 psi. In particular, the "wet" pressure treatment results in a fabric which retains more of the original tensile strength than one from a "dry" heat treatment.

FINISHING ARNEL FABRICS

We have always taken the position in our textile research that the objective of finishing is to enhance the properties of a properly designed fabric, rather than to substitute finishing for fabric construction. In addition, we have concerned ourselves with durable finishes, since, in the washable garment applications where Arnel properties are ideally suited, a finishing effect must be preserved for a substantial part of the useful life of the garment. On a nonreactive molecule like cellulose triacetate, only those finishing processes that involve insolubilization of materials on the surface of the individual fibers have a possibility of success. For this reason we have given a large part of our attention to the silicones. However, we will discuss softeners, durable and nondurable antistatic agents, and our preliminary work on durable bodying or stiffening agents. Pleating, embossing, and napping must also be considered part of finishing.

WASHING AS A FINISHING TREATMENT———If the general definition of a finishing treatment is that it improves finished-fabric properties, then washing after heat treatment fits this description. Where fabrics are to be converted into washable garments, a final wet treatment has been found to have the desirable effects outlined in Table XVI.

TABLE XVI
EFFECT OF WASHING AFTER HEAT TREATMENT

1) Stabilization of hand of fabric to that which will be observed after washing.
2) Improvement in wrinkle performance through removal of finish, bonding of adjacent fibers and mechanical relaxation of yarns.
3) Improved tear strength where surface stiffening agents are applied.
4) Reduction in staining by removal of last traces of surface dye.
5) Removal of discolorations, usually yellowing, due to the effect of heat treatment on inhibitor and other surface impurities. This results in the true shade, which will be retained on repeated washings.
6) Permits application of substantive inhibitors, softeners, and antistatic agents, which would decompose if applied before heat treatment.

SILICONES———The silicone resins, applied to Arnel fabrics before heat treatment and given a flash cure during dry heat treatment, have been found to impart all of the desirable effects previously reported for secondary acetate fabrics. These include durable water repellency and spot resistance to aqueous-born soil when 1% or more of silicone is applied. However, since we are more interested in the improvement of mechanical properties, most of our recommendations involve the application of 0.5% silicone for improvement in tongue tear strength, flex abrasion and sewability. In addition, we have noted that silicone finishes applied before heat treatment prevent the adhesion of adjacent fibers and yarns, and this minimizes the tendency of the fabric to stiffen and harshen.

One of the shortcomings of the surface-lubrication effect of silicone finishes is that they usually impart a smooth surface to the individual fibers, which in a taffeta fabric results in yarn slippage and the wrong type of hand. The use of a combination of silicone resin with a very fine-particle-size silica dispersion results in a durable finish which minimizes yarn slippage and imparts scroop and rustle, which are desirable in taffeta.

It will be noted from Table XVII that the silicone resin alone significantly raises the tear strength and the flex-abrasion resistance of a taffeta and lightweight

TABLE XVII
EFFECT OF SILICONE AND SILICA ON ARNEL FABRIC PROPERTIES

Fabric	Finish	Hand	Spray Rating		Elmendorf Tongue Tear, Lb		Stoll Flex Abrasion		Safe Ironing Temperature °F	
			Original	3 No. 2 Washes	Warp	Filling	Warp	Filling	Sticking	Fabric Stiffening
Sharkskin 150/3/40 Warp 2 ply 150/3/40 Filling	Original	Soft	0	0	3.3	2.7	102	102	338	392
	1% Silicone + Heat Treatment	Soft	100	90	6.8	6.4	212	485	482	482
Taffeta 75/2/20 Warp 150/3/40 Filling	Original	Slightly Firm	0	0	0.8	0.8	47	48	320	392
	1% Silicone + Heat treatment	Slightly Firm	100	90	2.4	2.3	133	292	446	464
	1% Silicone 0.3% Silica + Heat treatment	Crisp, Scroopy	100	90	1.2	1.4	70	115	446	464

TABLE XVIII
DURABILITY OF SILICONE FINISHES TO WASHING

Arnel Fabric	Silicone Used	Heat Treatment	Spray Rating		Tongue Tear, Lb				Flex Abrasion			
					Original		5 Washes		Original		5 Washes	
			Original	5 Washes	Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling
Dress Suiting												
Filament warp Spun filling 7 oz/yard	1) Dyed only	None	0	0	2.6	2.2	3.0	2.5	65	81	76	79
	2) 1% Silicone #1	Radiant heat	100	80	12.4	8.9	8.2	6.3	478	629	508	555
	3) 1% Silicone #2	Radiant heat	100	90	12.7	8.8	7.9	7.1	648	651	450	718
Taffeta												
2.9 oz/yard	1) Dyed only	None	0	0	0.4	0.3	0.5	0.6	33	25	31	51
	2) 1% Silicone #1	Radiant heat	100	80	3.2	3.6	1.8	2.0	Slippage		176	297
	3) 1% Silicone #2	Radiant heat	100	80	3.0	2.8	1.7	2.1	Slippage		427	260
Spun Shirting												
2/1 twill 4.5 oz/yard	1) Dyed only	None	0	0	2.9	3.2	2.1	2.2	58	51	40	24
	2) 1% Silicone #1	Radiant heat	100	80	6.3	5.4	5.8	6.6	Slippage		227	143
	3) 1% Silicone #2	Radiant heat	100	80	7.2	6.4	6.7	6.2	Slippage		621	314

sharkskin. The addition of the silica to the padding formulation for the taffeta resulted in a lowering of the improvement in tear and abrasion properties, but these were still better than those of the original fabric.

The durability to washing of silicone finishes is illustrated by Table XVIII.

The silicones may be applied before heat treatment on any of the dry-heat systems without contributing to discoloration during heat treatment. In addition to yarn and seam slippage, silicone-finished fabrics tend to retain more static charge. It is possible to eliminate this by applying antistatic softeners, which do not discolor in the same bath before heat treatment, or by padding the finished fabric after heat treatment.

Where silicone finishes have been formulated to impart a drier and firmer hand, less improvement in tear and abrasion performance are to be expected.

ANTISTATIC SOFTENERS———This family of finishing materials is familiar to finishers of acetate, nylon, and Dacron. It serves the purpose of providing 1) a temporary protection against static in the conversion of the fabric to garment, 2) elimination of static attraction of lint until it is washed or cleaned by the consumer, 3) a sewing lubricant, and 4) a soft and pleasant hand on the proper fabric constructions. Extensive examination of commercially available softeners revealed that there are very few which do not yellow or decompose on being heat-treated at 428 to 464° F (220-240° C) for 10-20 seconds. In particular, Arnold, Hoffman Co's Ahco 111 Paste, a cationic, and Ahcovel NC, a nonionic finish, stand up well and provide different types of hand and antistatic protection on Arnel fabrics whether applied before or after heat treatment. Figure 10 illustrates the effect of incorporation of Ahco 111 in combination with a silicone as a fabric finish. A silicone-finished fabric without antistatic agent rubbed against wool attracts cigarette ashes, whereas the finish containing Ahco 111 does not.

DURABLE ANTISTATIC FINISHES———To date only two antistatic finishes have been determined to have any promise for imparting durable antistatic properties to Arnel. These are DuPont's Zelec DP and Carbide and Carbon's Niatex Antistatic AG-1. Both yellow when applied before heat treatment and curing on the fiber. Yet this kind of treatment is required to impart maximum durability. Table XIX lists the resistivity of these finishes in comparison with some of the nondurable finishes applied before and after heat treatment.

In laboratory evaluations log values of less than 11 will not give static difficulties at relative humidities above 40% at 65° F.

BODYING AND STIFFENING AGENTS———While there is little difficulty in achieving a range of durable soft hands through the use of silicone resins and of modifying these hands by the addition of silica, it has not been possible to impart a washable, firm, and bodied hand by application of finish to such fabrics as butcher linens, and slack and suiting fabrics. Arnel triacetate fiber provides a relatively unreactive surface, so that finishes will have to be deposited on the surface rather than by reacting with the surface of the fiber. It does not appear to be feasible to stiffen the Arnel fiber intrinsically.

Two principles have been investigated:

1) Applying cross-linking or polymerizing materials as stiffening films around the individual fibers.

2) Applying an elastic polymer on the fabric so that flexible bridges are formed between fibers and between yarn bundles.

Fabrics treated with polyvinyl alcohol and a urea-formaldehyde or melamine-formaldehyde cross-linking agent retained a firmer hand even after five washes. However, the wrinkle performance was also reduced. A melamine-formaldehyde formulation containing American Cyanamid's Aerotex 159 also produced a durable hand.

However, a nonreactive finish is showing some promise in that Rohm & Haas' Rhoplex WN-75 polymer emulsion applied to a variety of fabrics shows some durability to washing. On ironing, these fabrics become even firmer because of the melting and rebonding of surface polymer.

PLEATING AND EMBOSSING——— The relatively high softening point of heat-treated Arnel fabrics, as well as insensitivity to hot-wet conditions, suggests that pleating and embossing may be successfully applied.

PLEATING———The property that permits Arnel fabrics to be relaxed and reset at elevated temperatures lends itself to the introduction of durable pleating. Preliminary experience reveals that autoclaving of the hand- and machine-pleated fabrics or garments at a steam pressure of 10-20 psi for 15-30 minutes is sufficient to produce a pleating durable to repeated washing. The construction of the fabric and its heat-treatment history influence the effectiveness of the pleating.

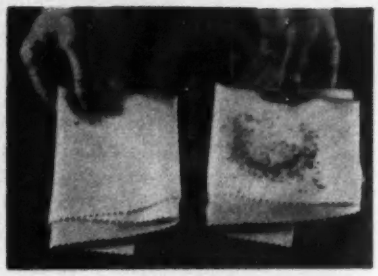


Figure 10

Antistatic treatment for prevention of soil-age attraction (treated fabric, left)

Skirts prepared from pleated tricot-knitted fabrics have been machine-washed 20 times with retention of the pleated appearance. Medium-weight combination dress fabrics with continuous-filament warp and spun filling have been pleated and washed many times with good retention of satisfactory appearance.

Preliminary work with Arnel blends with cotton, rayon, and wool is sufficiently promising to suggest that Arnel will find a large application in pleated garments. Figure 11 shows a pleated tricot fabric which has been worn and washed in the home laundry at least ten times.

EMBOSSING———Arnel fabrics may be embossed on the same hot-roll systems being used to process resin-treated cottor fabrics. On previously heat-treated fabrics, embossing and surface-glazed patterns have been found to be machine-washable. However, deeper patterns tend to flatten out, although the original design is visible even after 15 machine washes. Thermo-

TABLE XIX

ELECTRICAL RESISTIVITY OF ARNEL FABRIC FINISHED WITH VARIOUS ANTISTATIC AGENTS

Agent	%	*Applied Before or After Heat Treatment*	*Log of Electrical Resistance (Ohms) (50% R H @ 65° F)* Unwashed	1 Wash
Zelec DP	3.00	Before	10.9	9.8
Zelec DP	3.00	After	10.3	9.9
Niatex Antistatic AG1	3.00	Before	10.6	10.0
Niatex Antistatic AG1	3.00	After	10.4	12.0
Zelec NE	1.00	Before	9.6	15.1
Zelec NE	1.00	After	8.5	15.3
Trepostat 8-30	0.75	Before	9.7	14.3
Trepostat 8-30	0.75	After	9.1	13.6
Ahco 111	0.50	Before	11.8	15.1
Ahco 111	0.50	After	9.7	14.6
Ahcovel NC	0.75	Before	11.1	14.0
Ahcovel NC	0.75	After	9.7	15.2
Original, no finish	0.00		15.0	15.0

Figure 11
Pleated Arnel tricot skirt after 10 alternate wearings and home-laundry washes

setting resins are being investigated to improve the durability of the deep embossings.

The application of silicone resins prior to embossing tends to reduce the sharpness of the pattern because of interfiber lubricity. However, fabrics of significantly greater tear strength are obtained.

DYEING AND FINISHING ARNEL-BLENDED FABRICS

A thorough discussion of even the preliminary information available on dyeing and finishing Arnel blends with cotton, rayon, wool, nylon and Dacron would be too lengthy. For the purposes of this paper we are summarizing some of the principles and problems encountered. It has been clearly understood in the development of optimum fabrics that, for many end uses, the blending of suitable fibers makes possible the achievement of improved performance at the lowest cost.

ARNEL-COTTON ——— Arnel-cotton blended fabrics can be handled in either continuous cotton-processing systems or in the synthetic fiber dyehouse. This provides a versatile basis for favorable economics, styling, and flexible processing systems.

Arnel-cotton fabrics have been processed through standard caustic-mercerizing ranges without significantly saponifying the Arnel (Table XX) with achievement of the desired brightening and cleaning effects on the cotton. The cotton in the Arnel blend has been dyed with the following dyestuffs:

1) Direct dyes of the fixable type in cotton and synthetic processing.
2) Soluble vats on the winch.
3) Alkaline vat pigments by padding and reduction on the Williams range.
4) Naphthol dyeing in a continuous range.
5) Leuco or soluble sulfur dyes in a continuous range.

The effect of processes on the acetyl value of the Arnel and the color fastness properties on the cotton are recorded in Table XX.

Although Arnel-containing fabrics can be processed in mercerization and in alkaline dyeing on continuous ranges with very little saponification, kier boiling completely saponifies the Arnel component. However, excellent whites and the bleaching of foreign material can be achieved by a combination of mercerization and an alkaline hypochlorite-Textone treatment.

Preliminary trials indicate that Arnel-blended fabrics containing up to 40% cotton as a uniform blend, not cotton warp-Arnel filling, etc, can be finished without cross-linking resins with the achievement of less than 2% boiling shrinkage. Where copper- or resin-fixable direct dyes are used, it is essential to add a durable lubricant, such as American Cyanamid's Permel or a silicone, to the resin pad bath to minimize the reduction in tear and abrasion properties. Although Permel may find its greatest usefulness on Arnel blends with cotton and rayon, it is also a durable water-repellent and surface lubricant on 100% Arnel.

Vat- and sulfur-dyed Arnel-cotton-blended fabrics may be taken into the winch, and the Arnel dyed up to union shades by the recommended procedures with the achievement of the same fastness level as indicated for 100% Arnel.

ARNEL-RAYON———All of the work with this blend has been carried out under synthetic-fabric-dyehouse practices. One-bath union dyeings with selected disperse (acetate) dyes and fixable direct dyes have resulted in a wide range of shades, which give excellent home laundry washability at 140° F with satisfactory shade retention for at least 15 washes.

The resins and fixatives must be applied after heat treatment to minimize degradation and discoloration during heat treatment. A typical set of tear and abrasion data for a 70-30 Arnel-rayon blended fabric is recorded in Table XXI.

No serious dyehouse problems are anticipated with the Arnel-rayon blend. Where the rayon is reserved, it will not be necessary to resin-treat many fabrics of proper construction with up to 40% rayon in the blend. The Arnel apparently provides wrinkle and shrinkage resistance.

TABLE XX
EFFECT OF COTTON PROCESSING AND DYEING ON 50-50 ARNEL-COTTON BLENDED FABRIC

Processing	*Total % Combined Acetic Acid*	*Color Fastness*	*Color Effect On Arnel*
1) Scoured only	29.6		
2) Desized, mercerized, boiled off, bleached	30.0	Good white	Good white
3) Desized, mercerized, boiled off, bleached, continuous-naphthol dyed	30.2	Equal to 100% cotton	No staining
4) Same as #3 but continuous alkaline vat dyed	30.2	Equal to 100% cotton	Some colors dye lightly
5) Same as #4 but sulfur-dyed	30.6	Equal to 100% cotton	Some colors union-dye Arnel

TABLE XXI
EFFECT OF RESIN AND FIXATIVES ON ARNEL-RAYON BLENDED FABRIC

Processing	*Tongue Tear, lb*		*Flex Abrasion, Cycles*	
	Warp	*Filling*	*Warp*	*Filling*
1) Scoured and dyed	3.7	3.4	283	289
2) Scoured, dyed and radiant heat treated	3.1	3.1	236	230
3) #2+3% Permel +3% M-3 Catalyst G8 +Cuprofix 52	5.0	5.0	320	287
4) #2+5% Cream 450 3% Permel B* +Catalyst G8 +Cuprofix 52	4.7	4.2	434	364
5) #2+3% M-3, 1% DeCetex 104 Cuprofix 52, Catalyst G8	5.8	5.4	294	364

* Permel B is a new American Cyanamid product compatible with copper fixatives.

ARNEL-WOOL———Most of our work with this blend containing up to 50% wool has been carried out under dyehouse conditions for synthetics, the wool being treated as a synthetic fiber. The main dyeing problem results from the staining properties of the disperse dyes, especially the anthraquinone blues, on the wool with resultant inferior light, wash and sublimation fastness. A three-bath dyeing procedure has been worked out emphasizing the principles outlined in Table XXII.

TABLE XXII
3-BATH PROCEDURE FOR DYEING ARNEL-WOOL BLENDS

1) Selection of disperse dyes, especially blues, with good fastness properties and least staining on the wool.
2) Use of accelerants and conditions which favor exhaustion of disperse dyes onto the Arnel.
3) Effective scour to strip maximum of dye from wool.
4) Dyeing of the wool with best premetalized wool dyes from bath buffered with ammonium acetate.

The wool in Arnel-wool blends prevents use of optimum heat-treatment conditions for Arnel, since temperatures above 428° F (220° C) result in discoloration and reduction in strength of the fabric. The application of silicones before heat treatment tends to reduce the tear and abrasion loss.

The application of recommended procedures for dyeing and finishing Arnel-wool-blended fabric results in satisfactory fastness to AATCC Wash Test No. 2 at 120° F with respect to shade change and staining, 20-40 hours' light fastness, 2 cycles' resistance to gas fading, and good glazing, crocking and ironing properties.

Arnel-wool fabrics produced from yarns spun on the cotton system and dyed and finished in the dyehouse for synthetics offer an economical basis for many end uses.

ARNEL-NYLON———For special uses, particularly slacks, suitings and outerwear garments, it may be advisable to blend Arnel with a reinforcing fiber for increased strength and durability to dry wearing. While nylon would appear to be the logical fiber for this purpose, some of its dyeing and finishing properties introduce difficulties which require further research and development work. While it is possible to dye good unions on this blend with disperse dyes, the washfastness of these dyes is much poorer on nylon than on Arnel, and the colorfastness on nylon does not improve with heat treatment. Careful scouring to strip off the dye from nylon, either before or after heat treatment, permits the redyeing of the nylon with selected fast acid colors of the premetalized class, with the achievement of satisfactory fastness to repeated home washes at 140° F.

Normally, nylon fabrics are heat-treated at temperatures below 420° F. In addition, nylon will shrink up to 10% on heat treatment, whereas Arnel does not. Both of these factors may account for the substantial loss in tensile, tear and abrasion observed when Arnel-nylon blends are heat-treated under conditions required for the Arnel. Although the strength of heat-treated Arnel-nylon fabrics is still stronger than 100% Arnel in the same construction, intensive effort is justified in trying to retain the full contribution of the nylon.

One additional difficulty is experienced with nylon in the fabric, especially in combination and plied yarns where nylon appears in the face of the fabric. The glazing properties of nylon are not improved by heat treatment, and dark shades, particularly navies, will glaze on hot-bed pressing. Finishing treatments which will raise the surface softening point of nylon are under investigation.

ARNEL-DACRON———In many ways Arnel and Dacron should be considered an easy-to-process blend, since the dyeing and finishing properties of Arnel and Dacron are quite similar. Actually, there is no difficulty in dyeing what appear to be satisfactory unions for the complete range of shades. This is particularly true where pressure dyeing at 248-266° F (120-130° C) is possible. A number of accelerants based on orthophenylphenol and methyl salicylate have also been found to give satisfactory union dyeing at 205° F (96° C) on the jig and winch.

The problem, however, is to achieve balanced color fastness. The only red dye we have evaluated to date which gives passable sublimation fastness on Dacron is Celanthrene Cerise B, and this dye will not pass the No. 3 AATCC (160° F) Wash Test on the Arnel component. Thus, while Arnel gives good sublimation fastness with many dyes, these same dyes on Dacron are poor for sublimation. Conversely, many dyes which have good washfastness on Dacron are not passable on Arnel. With the cooperation of the dye industry, improved structure should become available for achieving more balanced color fastness on this blend.

TABLE XXIII
PERFORMANCE PROPERTIES OF 100% ARNEL FABRIC

SLACK FABRIC, 2/1 TWILL

Yarn Size:	14/1 warp and filling
Loom Count:	99 x 50
Finished Count:	105 x 52
Color:	charcoal grey
Weight/sq yd:	7.8 oz

FINISHED-FABRIC PROPERTIES

Percent Crimp:	6.8 x 3.6			
Thickness:	0.0180 mils			
Air Permeability:	75.0 cu ft/minute/sq ft			
	Warp		*Filling*	
	Dry	*Wet*	*Dry*	*Wet*
Strip Tensile Strength (lb/inch)	64.3	49.7	32.8	24.3
Percent Elongation	22.1	31.0	12.9	20.9
Tongue Tear Strength, lb	3.7	3.4	3.6	2.0
Flex-Abrasion Cycles	206	166	270	185

Wrinkle Performance
Celanese Wrinkle Tester: 1 hour, good
48 hours, excellent
Monsanto Crease Recovery:
warp, 138; filling, 141
Maximum Ironing Temperature: 464°F(240°C)
Degree of Glazing: dry iron, slight
steam iron, slight
Hoffman pressing, slight

DYEING AND FINISHING DETAILS

Dyes: Lenra Blue RLS
Eastone Red GLF
Interrham Yellow HDLF-40
Celanthrene Violet BGF
Chemical Finish Before Heat Treatment:
DeCetex 104, DeCetex 108
Sytox W-20
Heat Treatment: Infrared heat at 440°F, fabric-surface temperature
After Scour: 5% Empulphor ELA-719 at 176°F(80°C), 30 min.
Finished Hand: Aheo 111 antistatic softener

COLOR-FASTNESS PROPERTIES

Launderability: machine wash at 140°F
Shade change: negligible
Dimensional change: warp, 1.3%; filling, 0%
Retention of hand: excellent
Degree of wrinkling after washing and tumble drying: slight
Retention of surface appearance: excellent
AATCC Wash Test No. 3 (160°F)
Shade change: 4-5
Staining: 4-5 (very slight on nylon)
Crock Fastness: dry 5, wet 5
Light Fastness: 40 hours, 4-5
Gas Fading: 2 units, 4-5
Ozone Fading: 36 hours, 4-5

SUMMARY OF THE PERFORMANCE PROPERTIES OF ARNEL FABRICS

Sufficient data have been presented to suggest that Arnel and Arnel-blended fabrics can be processed efficiently in the wide variety of dyeing and finishing processes available to the textile industry. Throughout this presentation the relationship of the specific processes to the level of performance of the fabric has been noted. It must be clearly understood that an extensive study of fiber and fabric properties is required to achieve a maximum of the desired end-use performance. For many specific end uses, it may be economically impossible to attain the maximum level required. However, Table XXIII gives what might be considered balanced performance properties for a 100%-Arnel slack fabric.

ACKNOWLEDGMENTS

This paper is the summary of the work of several Celanese Research and Development sections.

In addition to the Celanese personnel, many individuals in commission dyehouses and customer mills have contributed to the verification of the processing properties of Arnel-containing fabrics.

While it is not possible to acknowledge all of those who contributed to our present knowledge of Arnel, mention should be made of Victor S Salvin for the critical selection of disperse dyestuffs, to William J Myles and B Sheldon Sprague for the development of heat-treatment processes and the interpretation of the data, to Ruth A Walker for the study of color fastness, to John R Adams, Jr, for the developed-black processes, to Werner A Schoeneberg for the scouring and bleaching studies and the dyeing and finishing of blends, to Norman Van Gorder for the development of special finishes, to Paul A Studer for the kinetics of dyeing studies and the development of printing with disperse dyestuffs, to George C Ward and William T Normand for the extensive application work under commercial conditions, to Jerome Rudy for the mechanism of dyeing-accelerant action and the development of practical accelerant dyeing systems, to Howard F Elsom for the evaluation of the performance properties of many of the fabrics and to George Maynard for the dyeing of blends.

We are indebted to several commission dyehouses for their wholehearted co-operation in preliminary dyeing and finishing trials, which provided a sound basis for further development work.

Special mention is given to the management of the Celanese Corporation of America for its foresight, to A F Tesi for his editorial assistance in preparing this paper, and, in particular, to Reiner G Stoll for his encouragement and leadership.

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QUESTIONS & ANSWERS

Question: To what extent is shade matching complicated by changes which ooccur during the heat treatment?

Answer: Slight shade changes have been noted as a result of the heat treatment of certain critical shades. These changes are much less than those normally experienced with the resin fixation of direct dyestuffs on cotton and rayon. They are due in part to redistribution of the slow-dyeing dyes which, after normal jig or winch dyeing, are present as a ring in the outer 25-50% of the fiber cross section. On heat treatment, there is a significant diffusion of the dye toward the center of the fiber.

In addition, certain finishes and residual dyebath components will discolor on heat treatment, producing an effect on shade. A simple light scour will remove most of this source of shade change. There is another shade change which comes from a smoothening of the surface on heat treatment and results in increased reflectance. Calendering or washing will tend to break up and reduce this source of shade change.

Although the shade change which occurs on heat treatment may be considered slight, it will be necessary for the dyehouse to match shades by doing exactly what it does now, excepting that a heat treatment must be applied after the sample patch is dried. It is very likely that a laboratory radiant-heat-treatment instrument will be developed in the near future to facilitate patch testing for color matching.

Q: I noticed that most of the different dyestuffs mentioned are quite like those ordinarily used on acetate. How do they compare on Arnel? Are they any better than the same shade on acetate?

A: The list of recommended dyestuffs outlined in Table VII represents a critical selection of available dyes based on their balanced performance properties for washfastness as well as for gas- and light fastness. In most instances they are of the slow-dyeing disperse type and they will dye more slowly on Arnel than on acetate under comparable conditions. The use of closed jigs and winches in dyeing at the boil permits the achievement of commercial shades on Arnel. For heavy shades, such as navies, the use of dyeing accelerants is recommended.

Whereas on acetate washfastness satisfactory at the #2 AATCC Test (120°F) may be achieved, on Arnel a wide range of shades satisfactory at the #3 AATCC Test (160°F) may be achieved. The light and gas fastness are comparable on acetate and heat-treated Arnel.

It should be noted that all properties of Arnel fabrics presuppose adequate heat treatment.

Q: Is Arnel usable in any form other than in woven fabrics, e g, has it been evaluated in nonwoven fabrics?

A: There is no basic reason why Arnel fiber cannot be used in nonwoven fabric applications. Its slow moisture regain properties and chemical inertness may actually give Arnel an advantage in this type of application. Proper adhesives or binding agents should not be difficult to develop since polyvinyl acetate has very good adhesion on Arnel. In addition, it should not be difficult to develop plasticizers for adhesion binding of nonwoven sheets.

To date we have no experience with the application of Arnel in nonwoven fabrics. Regular acetate is sufficiently useful and promising in this application so that there is no urgent need for an Arnel substitute.

Q: Can you produce a white discharge on Arnel?

A: Navy shades based on Eastman Dischargeable Blue CFD can be satisfactorily discharged to a white ground with the use of zinc formaldehyde-sulfoxylate. Sodium formaldehydesulfoxylate does not penetrate Arnel to the same degree as on regular acetate, and an only partial discharge is obtained. In general, Arnel triacetate is more difficult to swell and penetrate than regular acetate.

The shortcomings of dischargeable dyestuffs on Arnel are the same as on acetate, in that the light fastness generally is poor.

Q: Was it necessary to wash all of the several-hundred-thousand yards of Arnel fabrics processed in your Hopewell plant after heat treatment?

A: Actually not more than 5-10% of these fabrics were washed after heat treatment. Very heavy shades were washed after heat treatment to reduce the staining properties at the #3 Test, by removal of a very small amount of surface dyestuff. Certain pastel and light shades, such as Turquoise, were washed to remove the very slight yellowing discoloration. In general, however, it should be noted that a wash after heat treatment may be considered as a finishing process since, in addition to stabilizing the shade, it permits the achievement of a relaxed fabric of improved wrinkle performance, dimensional stability, and hand.

Q: In your paper you emphasized the excellent shrinkage resistance of Arnel fabrics. At the same time you have mentioned the absence of substantial shrinkage in scouring and dyeing of Arnel fabrics as a handicap in closing up loosely woven fabrics. Yet in your last slide you show a 2x1 twill slack fabric which shrank 6% warpwise and 4% widthwise.

A: You were referring to the change from a loom count of 99x50 to a finished count for this fabric of 105x52. This is actually a very small change due to shrinkage and going from a greige fabric from which size and various residual strains are being removed in scouring and dyeing. You will note that this same fabric when finished gave a dimensional change of 1.3% warpwise shrinkage and 0% filling shrinkage on washing in the home washer at 140°F. This is excellent dimensional stability for a fabric which has not been given any shrink-resistant finishing treatment.

Q: You say it is possible to get shrinkage in 100% Arnel fabric?

A: Arnel fabrics which have been heat treated under strain, e g, excessive warpwise tension or in a hot air frame with unbalanced air currents, can be appreciably distorted; thus a 45-inch-wide spun fabric processed in a clip frame with unbalanced air currents may come out as wide as 47 inches. On washing, a significant part of this stretching is recovered by shrinkage. In addition, a properly heat-treated Arnel fabric, which is then handled under stretching conditions such as framing out to a wider width by overfeeding, will display a shrinkage recovery on washing.

Where optimum dimensional stability is required, Arnel fabrics should be handled with a minimum of stress after heat treatment.

Q: Would you say something about yarn dyeing?

A: It is possible to achieve the same level of uniformity and depth on package-dyed Arnel as may be achieved on regular acetate. The dyes recommended for jig and winch dyeing are also required for package dyeing. Wherever possible, pressure dyeing up to 250°F will give rapid achievement of heavy shades. These conditions of dyeing also impart most of the desired effects of dry heat treatment, such as safe ironing point, and improved glazing resistance. Surface dyes should be removed by an efficient scouring treatment, preferably a hydrosulfite strip with ½ g/l sodium hydrosulfite. The wash fastness achieved by pressure dyeing alone is not quite as good as that achieved by a final heat treatment. It is therefore recommended that, wherever stock dyed or package dyed yarns represent a substantial proportion of the resultant fabric, a final heat treatment be practiced for improvement of wash fastness as well as to relax the strains introduced in weaving.

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55-10

Education: MS, textile chemistry

Experience: Chemist, dye application and research

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7-18, 8-1

55-11

Education: PhD, chemistry

Experience: research chemist, organic, physical, textile

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7-18, 8-1

55-12

Education: BS, chemistry

Experience: analytical and experimental chemist, specializing on detergents

Age: 32; married; veteran; references; position in vicinity of New York desired but not essential

8-1, 8-15

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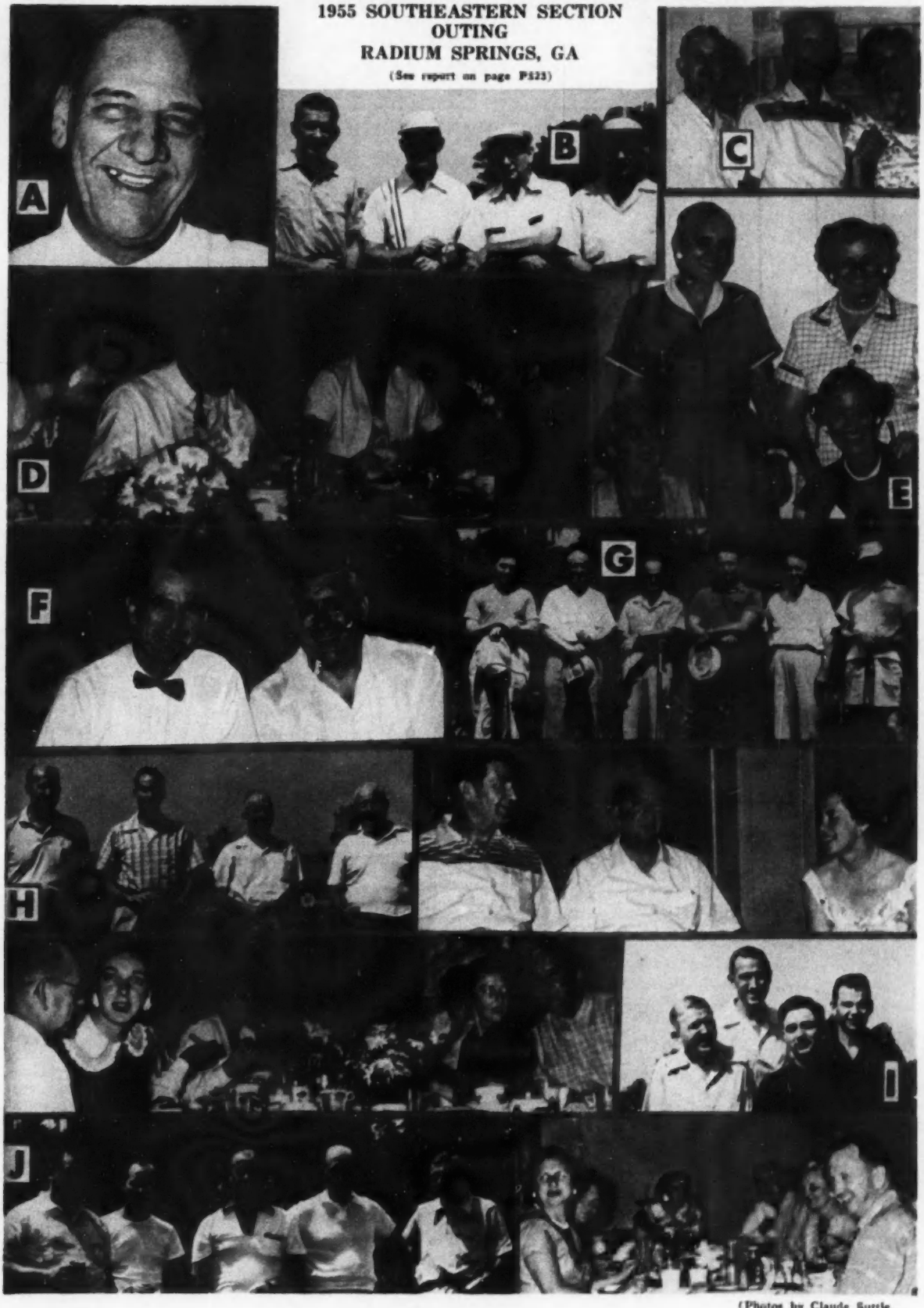

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News of the Trade

• Chwatt Bros Buys Manhattan Yarn Dye & Bleach

Announcement has been made by Samuel and Harry Chwatt, president and vice president of Chwatt Bros, Inc, of the signing of a contract for the purchase of buildings, realty and equipment of the Manhattan Yarn Dyeing and Bleaching Works, Inc, 233 Green Street, Brooklyn, N Y. Chwatt Bros are dyers and mercerizers of cotton and novelty skeins, including vats and wash-fast commercial colors. A subsidiary, Idana Package Dye Co, Inc, specializes in package dyeing of cotton and knitting yarns. With the new acquisition, specializing in the dyeing of wool, zephyr and other knitted outerwear yarns, Chwatt Bros will offer a completely diversified dyeing operation. All of the facilities will be located at the Green Street address about September 1st.

• United Wallpaper's Pigment Color Division Purchased by Harshaw

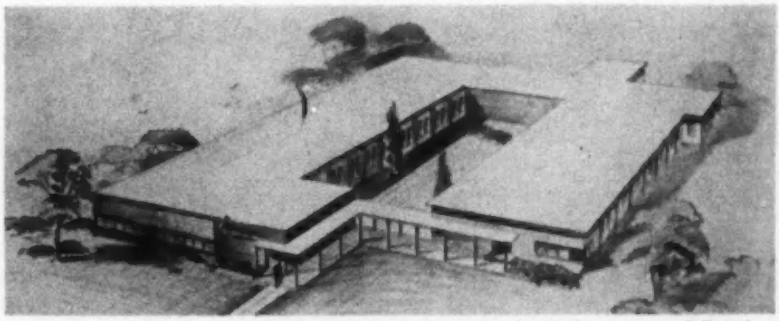
The Harshaw Chemical Company through its subsidiary, Zinsser & Company, Inc, has purchased the Pigment Color Division of United Wallpaper, Inc, and will move the manufacturing and laboratory facilities from Aurora, Ill, to the Zinsser Plant at Hastings-on-Hudson, N Y, on or about September 1st.

This line of organic and oxide pigment dispersions will continue to be sold under the brand name "Auraspers Colors" through the agents currently serving the domestic market.

John W Close, who has been manager of United Wallpaper's pigment color operations, will join the Harshaw organization to manage the sale of dispersed colors and will make his headquarters at Harshaw's sales office and warehouse in Chicago.

John F Birmingham will join the Zinsser staff at Hastings-on-Hudson, where he will devote his time to research and development, as will Lyde S Pratt, who has been retained by Harshaw in a consulting capacity.

The combination of these dispersed pigments with the dry and pulp colors produced by Zinsser will further expand Harshaw's list of products, and an intensive research and customer application program is planned to further improve and broaden the line.



Artist's conception of the expanded National Starch Products' Research and Development Laboratories, Plainfield, N J.

• National Starch Expansion Continues

The facilities of National Starch Products continue to be expanded with the opening last month of a second polyvinyl resin plant, and the beginning of an addition to the present Alexander Research Laboratories in Plainfield, N J.

The new polyvinyl resin plant, located at Meredosia, Ill, supplements the company's Plainfield plant in meeting demands for high quality polyvinyl resins with controlled physical properties. While its prime function will be to produce polyvinyl emulsion, it is also geared to manufacture adhesives containing large proportions of the vinyl emulsions for the company's National Adhesives Division. National plans to market this additional capacity of resin through its nationwide sales, warehousing and bulk handling set-up.

The additional construction at the Research Laboratories is part of a program to centralize and integrate the company's research, development and technical staff of over 150 people into this modern scientific center. Plans for the combined laboratory call for a one-story structure containing 30,000 sq ft, centrally located on a landscaped, 8-acre tract.

• Nopco Acquires Griffin Chemical

Perc S Brown, director and vice president in charge of Nopco's Western operations, has announced that Nopco Chemical Company has acquired the assets of the Griffin Chemical Company of San Francisco. Mr Brown stated that this is the initial step in Nopco's planned further expansion by acquisition on the Pacific Coast.

Everett Griffin, who organized the Griffin Chemical Company in 1935, has guided its growth as a manufacturer of substantial tonnages of petroleum sulfonates, napthenic acid, emulsifiers, plasticizers, and polyvinyl acetate emulsions. He will be associated with Nopco at Richmond, Calif, in an executive capacity.

• Stein Hall Establishes New Laboratories in Charlotte

Stein Hall & Co, Inc, has established the Southern Textile Laboratory and a Resin Laboratory at its Charlotte, N C, plant.

The Southern Textile Laboratory will be responsible for developing new textile products, particularly for sizing and finishing operations. It will offer general technical assistance to textile mills in the Company's Charlotte and Atlanta territories and will assist the Stein Hall Sales Division in promoting new products.

The Charlotte Resin Laboratory will engage in research on Stein Hall textile resins and resins for the paper, adhesives and other industries as well.

(See "Names in the News" for relative personnel appointments.)

• PTI Increases Tuition

A tuition raise of $100 yearly has been authorized for students of the Philadelphia Textile Institute by the Board of Trustees, to be effective this coming Fall semester.

The Institute, which has been able to hold its tuition constant since the Fall of 1948, has found it necessary to make this increase to off-set rising costs of operation. This increase brings the tuition for American Students to $550 a year and for Foreign Students $650. There is to be no change in the fees.

• New Sales Departments Set Up at Goodyear's Chemical Division

Three new sales departments have been established at the Chemical Division of The Goodyear Tire & Rubber Co, Inc, Akron, Ohio.

The reorganization of the division's sales headquarters, effective immediately, was announced by C O McNeer, general sales manager of the division, who stated that the new departments will be called Rubber and Rubber Chemicals, Plastics, and Coatings.

(Details of relative personnel moves will be found in "Names in the News").

• Allied Chemical to Market Deep-dye Nylon as "Caprolan"

Allied Chemical & Dye Corporation's polycapramide nylon filament yarns, staple fiber and tow, developed as the result of a ten-year research project, will be merchandised as "Caprolan,* the deep-dye nylon", according to George H Hotte, director of fiber sales and service, National Aniline Division.

The new deep-dye nylon yarns and fibers were introduced to the textile industry at the Knitting Arts Exhibition held in Atlantic City in April. On that occasion, Allied Chemical presented to the trade, for the first time, sharply contrasting cross-dyes of 100 percent nylon fabrics which contained both the new and the conventional nylon fibers. The cross-dye effects were shown in men's argyle socks made by the Interwoven Stocking Company, and in women's and children's sweaters and hosiery produced by Security Tricot Mills. Two-color patterns were achieved in a single dyebath where the two types of nylon were used, and three-color effects were obtained from a single dyebath where polyester fiber was added to the fabric.

Mr Hotte pointed out that "Caprolan" possesses excellent affinity for all classes of dyestuffs used on nylon, and is outstanding in affinity for the acid, direct, premetalized acid, chrome and vat groups.

In the near future, National Aniline Division expects to begin commercial production of "Caprolan, the deep-dye nylon" by an exclusive and novel process developed by the company and now under run-in tests at its recently completed Chesterfield Plant near Hopewell, Va. Experimental quantities of "Caprolan" are now being sampled in the textile trade, Mr Hotte said.

* Trademark—Allied Chemical & Dye Corporation.

• 55th NBITT Commencement

Senator Leverett Saltonstall (R-Mass), the recipient of an honorary Master of Science degree, was principal speaker at the 55th Commencement of the New Bedford Institute of Textiles and Technology held June 5th on the lawn of the New Bedford Jewish Community Center. Senator Saltonstall directed his address chiefly to graduates, who were told that they should be entering their chosen field with the feeling of optimism long common to American life.

In addition to Senator Saltonstall, honorary Master of Science degrees were conferred on Mark M Duff, a New Bedford banker and textile industrialist; Walter S MacPhail, Wamsutta Mills; John H McMahon, chairman of the board, Berkshire-Hathaway, Inc; John A Shea, Neuss Hesslein & Co; and Fred W Steele, executive secretary of the New Bedford Cotton Manufacturers Association. The ceremony was conducted by President John E Foster assisted by Joseph Dawson, Jr, chairman of the board of trustees of the Institute.

The graduating class was composed of the successful Bachelor of Science degree candidates and students who had completed shorter courses. The degree recipients included thirteen in textile chemistry, eleven in mechanical engineering, eight in textile engineering, and one in textile design and fashion. Betsey B Gillin received the American Association of Textile Chemists and Colorists Prize; Jose S Martinez, the American Association of Textile Technologists Award; George L Schmitt, the National Association of Cotton Manufacturer's Medal and Ralph P Boyd, the Textile Veterans Association Award.

Following the completion of the commencement exercises President Foster held a reception at the college for the graduates and their families.

NAMES IN THE NEWS

Sims

Hart

Schwarz

Election of WILLIAM LEE SIMS II as president of Colgate-Palmolive Company has been announced by E H LITTLE, chairman of the board, who will continue as chief executive officer of the company. RALPH A HART has been elected vice president of the company and also has been elected to succeed Mr Sims as president of Colgate-Palmolive International.

Mr Sims has been associated with the Colgate-Palmolive Company since 1924. He has been vice president in charge of the company's foreign operations since 1945 and executive vice president since 1952. He became a director of the company in 1946 and a member of the executive committee in 1953.

Mr Hart started with the Colgate-Palmolive organization in 1932. He most recently served as vice president of Colgate-Palmolive International in charge of European sales and advertising.

The Sandoz Chemical Works, Inc sales organization has named HERMAN L SCHWARZ to the position of assistant sales manager in the New York district.

Mr Schwartz joined the Sandoz organization in 1928. He has worked in the New York territory since that time and in January 1950 joined the technical sales staff.

As part of an overall expansion program, which will include construction of a new plant in the near future outside Philadelphia, W F Fancourt Co, Philadelphia, Pa, has announced the election of new officers as follows:

JOHN L FANCOURT, formerly vice president and director, has been named president and treasurer, succeeding the late WALTER F FANCOURT III; J THOMAS LINDLEY and EDYTH F MORRIS, vice presidents; and JOSEPHINE PATLA, secretary.

Mr Lindley has been sales manager in charge of Fancourt's Burlington, N C, office for the past eight years. Miss Patla has served with the Fancourt company for 33 years.

In addition to being named vice presidents, Mr Lindley and Mrs Morris were elected directors of the company.

LEWIS M COWEN has been named assistant plant manager at the Nutley, N J, plant of Atlantic Chemical Corporation.

The directors of American Viscose Corporation at their July 6th meeting elected GERALD S TOMKINS to the office of president. Mr Tompkins, who has been a vice president in charge of production, will be chief operations officer, while FRANK H REICHEL, chairman of the board, will continue as chief executive officer of the Corporation.

At the same meeting HARRY L DALTON was elevated to the office of vice chairman of the board from his former position of vice president in charge of sales.

WILLIAM H BROWN, secretary and treasurer of the Corporation, was elected a vice president. Mr Brown will also retain the office of treasurer and will be chief financial officer of the Corporation.

ALBERT H HAMMOND, formerly assistant secretary, was elected secretary of the Corporation.

Dr Reichel has announced the formation of three operating divisions, each to be conducted under a general manager who will report to the president. GEORGE L STORM was elected a vice president of the Corporation and appointed general manager of the Viscose Division, which will include staple fiber, tire yarn and viscose filament yarn. Mr Storm had been manager of staple sales.

PAUL E HILL was appointed general manager of the Acetate Division, which includes acetate and vinyon. Mr Hill has been general manager of acetate and vinyon production.

HAROLD J MICHEL was appointed general manager of the Film Division, which includes cellophane, viscose bands, casings and plastics. Mr Michel was formerly general manager of production in this Division.

The Nopco Chemical Company has appointed WALTER E BREWER as the new manager for its Textile Chemicals Division. Mr Brewer will be in charge of the field sales force and the home sales office of the Division.

Mr Brewer has been with Nopco since 1936. In his previous assignment, he was district sales manager for all industrial products, covering 12 of the east coast states.

According to Mr Brewer, Nopco will give special sales emphasis in the coming months to its line of Nopcostat antistatic lubricants for synthetic fibers and for blends of wool and synthetic fibers. He said that the Nopcostats have been very successful in maintaining a balance between antistatic properties, fiber-to-fiber cohesion, and fiber-to-metal lubricity.

Mr Brewer further stated that Nopco will intensify the sales campaign in behalf of its new warp-sizing agents for synthetic fibers. He mentioned Size N developed for use with nylon, and Size D for Dacron.

Ohio Falls, Inc, Louisville, Ky, has announced the appointment of J DORMAN COMPTON as superintendent of dyeing, and that of ROBERT J McBRIDE as Central Mid-West factory sales representative.

Mr Compton, who has ten years' experience in the dyeing and finishing field with Southern textile mills, will also assist in the modernization program now in progress at Ohio Falls.

Mr McBride will make his headquarters in St Louis to call on users and manufacturers of canvas products.

Brewer

Compton

McBride

Earhart

Sherman

Rhoad

Polson

Warner

Landry

Following announcement of the establishment of three new sales departments (Rubber and Rubber Chemicals, Plastics and Coatings) within the Chemical Division of The Goodyear Tire & Rubber Co, Inc, Akron, Ohio, C O McNeer, general sales manager of the division, disclosed the following managerial moves:

R S EARHART, sales operating and marketing manager, has been promoted to assistant general sales manager, and P S SHERMAN, assistant operating manager, has been named operating manager.

Under the net set-up, M J RHOAD, assistant to the general sales manager, becomes manager of the Rubber and Rubber Chemicals department; A E POLSON, sales service manager, takes over as manager of the Plastics department; and JOHN WARNER, manager of the division's St Louis district, has been appointed assistant manager of the Coatings department.

RITA P LANDRY has been appointed instructor of textiles in the College of Applied Arts at the University of California, Los Angeles.

Miss Landry, a former teacher of chemistry in the Science Department of Lowell (Mass) High School, is a graduate of Lowell Technological Institute. In obtaining her M S Degree from that institution, Miss Landry was an American Viscose Corporation graduate fellow under the supervision of the American Association of Textile Chemists and Colorists.

Several recent additions have been made to the sales staff of Hooker Electrochemical Co, Niagara Falls, N Y. Appointed as field sales representatives are GEORGE CHYNOWETH and JOSEPH J LENAHAN. JULIAN J BOYCE has been transferred from the Philadelphia sales area to cover the southeast with headquarters at Charlotte, N C. AMES N YOUNG 3rd has been given technical sales service responsibilities, working from the company's Tacoma, Wash, sales office and plant.

WALLACE R BRODE, associate director for chemistry at the National Bureau of Standards, received an Honorary Doctor of Science degree at the 96th Commencement of Whitman College in a special ceremony honoring one of its outstanding professors, the late BENJAMIN HARRISON BROWN. Dr Brode was one of several honored as distinguished science graduates of Whitman and former students of Professor Brown.

• NEW PRODUCTS AND DEVELOPMENTS •

• Denivat

To combat the problem of blue denims that lose their "blueness" after a few washings, Southern Dyestuff Corp has introduced Denivat, a blue vat dye. Denivat, applied via the vat-dyeing process, is said to penetrate and dye all the fibers of the yarn, leaving no white centers of cores to cause "white knees". Seats, edges, seams, knees and other parts of the garment exposed to the most severe wearing and washing are said to retain a deep rich blue tone throughout.

In commenting on the new dye, John L Crist, chairman of the board at Southern Dyestuff, stated that "for the first time retailers are now offering customers a color fast denim that won't whiten under abrasion, holds its blue color the entire life of the garment, and can be laundered with other articles of the family wash".

Southern Dyestuff calls Denivat-dyed denims "Everblue 'Thru-and-Thru' ". Quantity production by denim mills is under way in many popular constructions. Mr Crist estimates the new process will make possible many new end-uses in the denim field, particularly in the men's, women's and children's casual wear field.

• New Pfizer Products

Chas Pfizer & Co, Inc, 630 Flushing Ave, Brooklyn 6, N Y, is now making kojic acid available in commercial quantities. As a potentially important base in the manufacture of azo dyes, and in forming metal chelates, kojic acid will be produced by Pfizer's fermentation techniques. It is the latest in the company's new series of industrial chemicals made by this process.

Earlier products of the process are dimethyl itaconate and dibutyl itaconate, two new esters of itaconic acid.

Technical bulletins are available from Pfizer on request.

• Curing Oven Used as Dryer

Recent reports have suggested the use of high-production curing ovens as dryers, with controlled, uniform air circulation the key to success.

One such report shows that a 3-section Hunter Curing Oven-Dryer, holding 69 yards of 40-inch fabric, removes from 720 to 900 pounds of water per frame hour from synthetic, cotton, wool and blended fabrics.

In the case of the gas-fired Hunter unit, the placement of nozzles makes possible uniform temperatures throughout the length and width of the oven. In drying operations, this means that fabrics can be dried more evenly across their width and on both sides.

Photo shows two dresses which have been hand-washed, squeezed lightly, and hung on hangers to drip dry. Collar, cuffs, and hem have been smoothed and patted into place by hand. Dri-Smooth-treated dress has recovered, while untreated fabric requires pressing.

• "Dri-Smooth" Finish Said to Put Cottons in No-Iron Wash and Wear Class

"Dri-Smooth", an improvement on Cranston Print Works Company's Fresh-Tex finish in shrinkage and crease resistance, is said to make a cotton dress, skirt or pajamas wearable immediately after washing and drying, while virtually eliminating the need for ironing.

The new resin finish, which was developed principally for 80 x 80 4.00 carded print clothes, was introduced to the trade recently at a fashion presentation and wash-and wear demonstration, employing a Westinghouse standard home laundry washer and companion dryer.

Edward Lawrence, research director, pointed out that laboratory tests have been run on the basis of 10 or more washings and dryings, with the results compared to identical cotton garments giving only a regular mill finish.

"The difference between the multitude of wrinkles left in the untreated garment after washing and drying and the almost "freshly pressed" look of the Dri-Smooth treated garment is just about unbelievable," Mr Lawrence stated.

Mr Lawrence also called attention to the speeded-up drying time on the treated fabrics. Dri-Smooth-finished cottons reportedly dried twice as fast as the untreated fabric.

Other performance properties achieved through the Dri-Smooth finish are said to include shrinkage of not more than 2 percent, mildew resistance, the elimination of any need for starch, and the creation of generally faster, easier washing.

Laboratory tests are said to have revealed that it is possible to use Dri-Smooth on a wide variety of cottons with as high a count or higher than 80 squares.

It is reported that seven or eight print numbers, both white and dyed ground prints, are currently being finished with Dri-Smooth at the Cranston, R I, Webster, Mass, and Fletcher, N C, plants.

• Anti-Foam 60

Development of a new silicone antifoam agent that reportedly combines the high efficiency of the silicones with greatly improved ease of use in manufacturing operations has been announced by General Electric Company's Silicone Products Department. Designated Anti-Foam 60, the low-viscosity silicone emulsion has been designed specifically for use in aqueous foaming systems.

The major advantage claimed for Anti-Foam 60 is that it eliminates costly handling problems that have been associated with the use of conventional viscous, paste-type silicone antifoam agents in manufacturing operations. Anti-Foam 60 pours readily and disperses instantly, it is claimed, even in cold water. It can be added direct to the foaming system or can be easily diluted with water to any desired concentration. Little or no stirring is required.

It is claimed that the new antifoam agent will permit a 30 to 50 percent increase in the capacity of stills, kettles and other equipment; will help reduce processing time, since it permits continuous heating during distillations; and will help minimize fire hazards by suppressing flammable foams.

The high efficiency of Anti-Foam 60 reportedly permits the use of much smaller quantities than are required with other types of defoamers. This is said to reduce the danger of contamination while allowing the new emulsion to compete favorably with less expensive agents on an "applied cost" basis.

• Monamid 150 Series

Mona Industries, Inc is now marketing a new, additional group of fatty acid amine condensates under the name of Monamid 150 Series. These are said to contain 50% more amide than products sold previously as 100% active.

Products of the group are reported to be practically odorless and extremely light in color. The manufacturer recommends them for detergency, wetting, foaming, emulsifying, thickening, stabilizing and dispersing.

Technical Bulletin #222, covering the new series, may be obtained from Mona Industries, Inc, Paterson 4, N J.

• Ampitol VAC

A new nonyellowing cationic softener, claimed to be highly effective in the Avcoset process on rayons and rayon blends, has been announced by Dexter Chemical Corp, New York.

The softener, Ampitol VAC, is reported to give a soft hand with improved breaking strength and sewability when 1 to 3% is added direct to the Avcoset mix. It is said to disperse readily in the mix without precipitating out any of the ingredients.

Besides being nonyellowing, Ampitol VAC reportedly exhibits high antistatic characteristics when used as a straight finish, making it an excellent softener on nylon, Dacron, Orlon, Dynel, and other synthetic fibers. It can be applied either by the exhaustion method or by padding.

As a straight finish, 0.5 to 2% on the weight of the goods gives an excellent hand and high static control, it is claimed. In padding operations, 0.5 to 2% on the weight of the liquor is recommended.

• FCC Producing Chrome Chemicals in 2 Types

Fiber Chemical Corporation is currently producing chrome chemicals in the industrial grade (IG) and the technical pure (TP), which is close to the chemical reagent grade.

The following literature of interest to textile and fur dyers may be obtained by writing to Fiber Chemical Corp, P O Box 218, Matawan, N J.

Bulletin 300 lists 11 compounds in the hexavalent series and 20 in the trivalent series.

Bulletin G-287 presents specific data on FCC Chromic Nitrate TP 50% and FCC Chromic Nitrate Acetate TP, which finds use in textile printing.

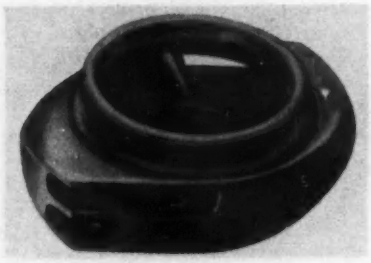
Specifications for FCC Chromic Acetate (Solutions), which is used in the manufacture of catalysts as well as a mordant in dyeing and printing, are given for Basic IG 18%, IG 30%, and TP 43% in Bulletin G-292.

Bulletin G-262 covers FCC Chromic Fluoride TP, which finds various applications in textile dyeing and printing, dyestuff manufacturing (chromiferous dyes), etc.

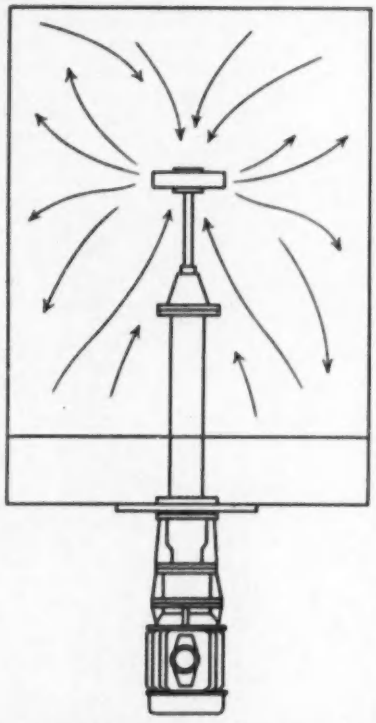
FCC Chromic Formate, of interest as a tanning agent, textile mordant, and an agent in the manufacture of chrome chemicals, is discussed in Bulletin G-291, which covers the Basic IG 21% and Basic TP grades.

• Rheinhuette Mixer

The Rheinhuette (German) mixer, which works on the principle of a centrifugal pump, is now available through Neumann & Weaver, Inc, 22-12 Raphael St, Fair Lawn, N J.



RHEINHUETTE IMPELLER —— When shaft is rotated rapidly liquid is drawn into large holes at top and bottom of impeller and driven out through slots on the sides.



Cross-section shows Rheinhuette mixing action.

Suited to a variety of textile wet-processing and other operations, the effect of the mixer is as follows: when the mixing tank is filled and the Rheinhuette impeller is rotated rapidly, liquid is sucked from both top and bottom and then driven out radially at different velocities toward the sides.

The mixing impeller consists roughly of an oval-shaped block with one circular opening at the top and another on the bottom, each connected by curved channels to slots on the sides. When the impeller is rotated, centrifugal force drives the liquid out radially through the slots—liquid then flows into the openings at top and bottom of the impeller to replace that which has been driven out. And as the impeller rotates more rapidly, the suction at the top and bottom of the impeller increases, so that heavy liquids or solids are drawn up from the bottom of the container and lighter liquids are drawn down from the top. At the same time, centrifugal force increases and the liquid is impelled outward, creating a violent mixing agitation, at greater velocity.

Current velocities reportedly are increased by the contour of the channels (there are 2 pairs of them) through which the liquid flows toward the slots. Each pair is of different size and shape, so that they emit liquid at a different rate of speed in a different direction radially.

• Aceto Offers New Chemicals

Aceto Chemical Co, Inc, Flushing, N Y, recently named sales agents for British Industrial Solvents in the United States, is now handling the following products, which heretofore were not generally available in the United States: beta picoline, pentanol-2 (high purity), methyl aceto acetate, and acetoacet m-4-xylidine.

Available in development quantities are acetoacet p-chloranilide, acetoacet o-anisidide, acetoacet p-toluidide, acetoacet p-anisidide, and bis-acetoacet o-toluidide.

British Industrial Solvents is a division of Distillers Company, one of the largest chemical manufacturers in England. Technical bulletins and samples on Bisol's products may be obtained from Aceto. Stocks of all Bisol products of interest in this country are warehoused in New York. The Bisol line is a noncompetitive addition to Aceto's line of fatty alcohols, higher alkyl chlorides, bromides and sulfates.

• Ludox Colloidal Silica

Ludox colloidal silica, a product of Du Pont research, was recently disclosed as a soil retardant which can keep rugs and carpets, upholstery, fabrics, and other surfaces clean and fresh-looking even when dirt is applied directly to them.

Ludox does its work by filling up soil receptor sites that all surfaces possess in varying degree. It is colorless, odorless and nonflammable.

First commercial application of this antisoil chemical has been made by the floor covering industry. The treatment of pile fabrics with a colloidal silica for imparting soil resistance was first disclosed in a patent issued to Mohawk Carpet Mills, Inc. Soil retardants based on Ludox are now being applied to new rugs and carpets by a number of manufacturers who have been licensed under the Mohawk patent. Some rug cleaners are now beginning to offer this antisoil treatment at nominal cost to their customers.

Ludox colloidal silica is manufactured in a Du Pont plant at East Chicago, Indiana.

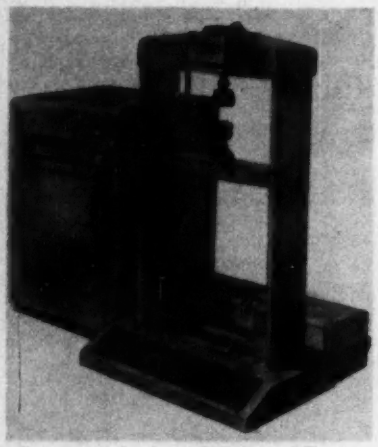


Table-model—Instron Universal Testing Instrument

• Table-model Instron Tester

A new table model of the versatile Instron universal testing instrument, introduced last spring by Instron Engineering Corp, 440 Hancock St, Quincy, Mass, has attracted considerable interest in the textile industry. The instrument records with electronic accuracy stress-strain curves under tension and compression.

Full-scale load ranges from 2 grams to 200 pounds are available through the choice of three load cells. Inertialess weighing is said to permit rapid response to load fluctuations in the sample which enables a heretofore unobtainable degree of accuracy in an instrument in this price range. The high-speed recorder is equipped with a choice of synchronous chart speeds to provide a range of extension magnification.

The crosshead is driven synchronously through fast-acting magnetic clutches and change gears to provide a choice of constant and reversible testing speeds over a range of 250 to 1. This range can be either from 0.2 to 50 inches per minute or, in an alternate model, from 0.02 to 5 inches per minute, with an available jaw travel of 30 inches. The rapid traverse speed can be selected by similar change gears over a speed range from 50 to 2 inches per minute, or alternatively 5 to 0.2 inches per minute.

A space of 3 inches is provided around the crosshead assembly to enable the use of special conditioning chambers, without modification of the unit.

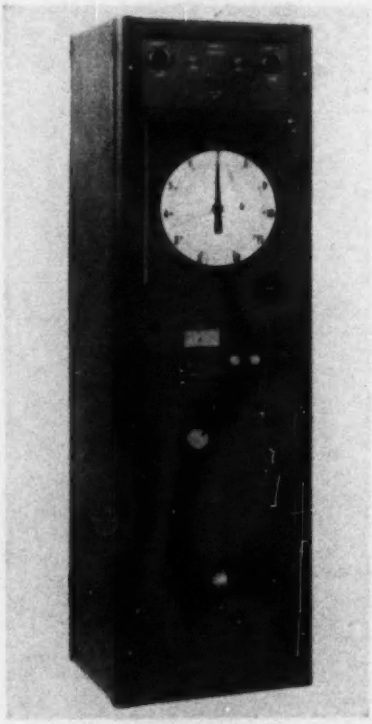
Accessory equipment is available to meet individual testing requirements.

• Factory-packaged pH System

The Beckman Division of Beckman Instruments, Inc, has made available a "packaged" pH control system for use in any pH process application.

These systems reportedly combine all the components needed for single or multiple-channel pH process monitoring, recording and controlling. The entire system is built at the factory, wired, piped and assembled ready for plug-in installation. The basic components can be assembled into a number of different combinations from the simple combination of pH meter and alarm to the multiple-channel monitor-recorder-alarm-control system.

For complete information request Bulletin 384 from Beckman Division, Beckman Instruments, Inc, Fullerton 1, Calif.



Beckman Packaged pH System

RSC Stainless-Steel Pail

• Stainless-Steel Pail for Handling Acids

A special stainless-steel pail has been developed by the Reading Scientific Company, 13th and Pike Streets, Reading Pa, for the handling of sulfuric acid and other highly corrosive chemical solutions. It has already been used in the bleaching, dyeing and finishing of textiles.

The pail, made from 24-gauge Carpenter Stainless No. 20, is said to be safe for use with both hot and cold sulfuric acid. It is especially recommended by the manufacturer for the process industries where strong corrodents have to be carried by hand from supply tanks to working installations.

Capacity of the pail is three gallons. It measures 11¼-in high and has a top diameter of 10⅜ in. The inside walls are welded, ground flush and polished. Type-304 stainless steel is used for the chime, handle and ears.

Corrosion rate of the pail is reportedly negligible through all concentrations of H_2SO_4 at room temperature. It is said to be highly resistant to all concentrations of sulfuric acid at 125° F (50° C). At boiling temperatures, it is claimed to be four to six times as resistant to sulfuric acid as a pail made from Type 316 or other 18-8 stainless steels.

GENERAL CALENDAR OF COMING EVENTS

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

National Convention—Sept 26-28, Lake Placid, N Y.

GARMENT DYERS GUILD OF AMERICA

Sept 9-10, Loebl Dye Works, Roanoke, Va.

THE FIBER SOCIETY

Fall Meeting—Sept 8-9, Massachusetts Institute of Technology, Cambridge, Mass; Spring Meeting—May 2-3, The Clemson House, Clemson, S C.

NATIONAL COUNCIL FOR TEXTILE EDUCATION

October 17-19, The Larches, Hopedale, Mass.

INTERNATIONAL WOOL TEXTILE RESEARCH CONFERENCE

September, 1955—Sydney, Melbourne, and Geelong, Australia.

NATIONAL COTTON COUNCIL OF AMERICA

1955 Chemical Finishing Conference—Sept 20-21, Chalfonte-Haddon Hall, Atlantic City, N J; 7th Annual Cotton Research Clinic—Feb 15-17, Pinehurst, N C.

NATIONAL INSTITUTE OF DRYCLEANING ALUMNI SOCIETY

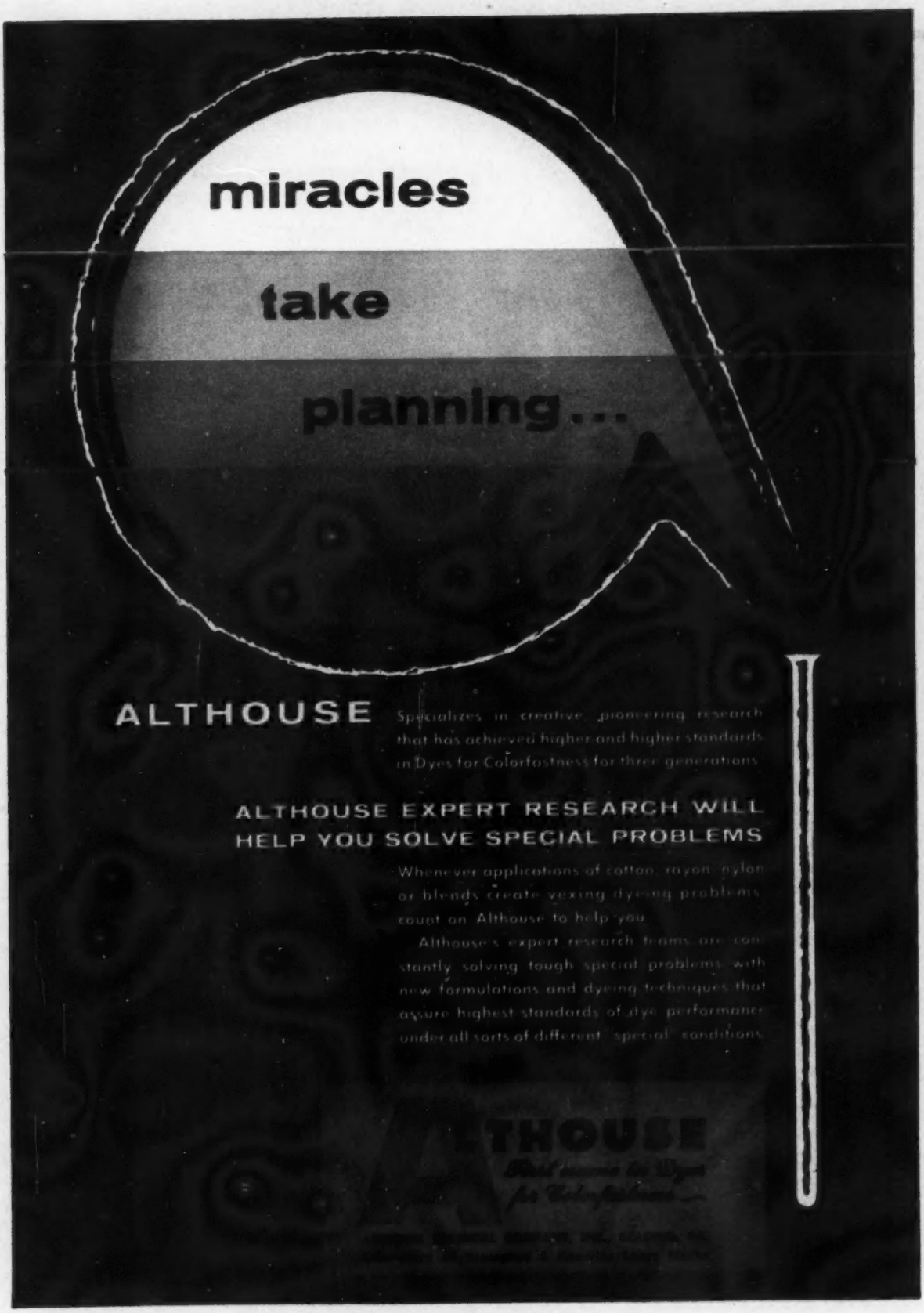
Annual Reunion—August 12-14, NID and Shoreham Hotel, Washington, D C.

PHI PSI FRATERNITY

Annual Meeting—April 19-21, Alabama Polytechnic Institute, Auburn, Ala.

SYNTHETIC ORGANIC CHEMICAL MANUFACTURERS ASSOCIATION

Sept 14, Oct 11, Nov 9 (Hotel Commodore, New York, N Y).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Advertisements in this section are restricted to HELP WANTED—POSITIONS WANTED—EQUIPMENT wanted or for sale. Rates, effective February 1, 1951: One-time, $10.00 per column inch; 3 consecutive times (same copy), $9.00 per column inch; 13 or more times, $8.00 per column inch; Position Wanted, $2.00 per column inch. Figure 38 average words per column inch. Publisher reserves the right to reject or discontinue any classified advertisement. Replies should be addressed: Box Number . . . c/o American Dyestuff Reporter, 44 East 23rd Street, New York 10, N. Y.

ABSTRACTING SERVICE—Abstracting and digesting of foreign patents and periodicals. Literature review and special reports in dyestuff and cellulose chemistry. PAUL WENGRAF, 88-36 ELMHURST AVENUE, ELMHURST 73, NEW YORK.

POSITION WANTED: Production Manager, Colorist, Supervisor, in textile screen printing or allied fields. Customer liaison and business experience. Cost conscious. Will relocate. Write Box No. 876.

POSITION WANTED: Textile college graduate. Chemist. Diversified experience dyeing, finishing, auxiliaries manufacturing. Good administrative background. Age 33. Seeks responsible position plant or technical sales. Presently assistant superintendent dyehouse; plant chemist. Write Box No. 926.

DYER WANTED: With technical background or practical experience of at least five years, as night supervisor for Georgia knit goods plant. Write in detail your background and salary desired. Write Box No. 935.

POSITION WANTED: TEXTILE CHEMIST AND COLORIST. Director of dyestuff application laboratory. Expert in standardizing, color matching and testing of all classes of dyes on all fibres, dyeing and printing. Considerable experience in technical sales and administration. Seeks responsible position. Will consider sales. Write Box No. 939.

POSITION WANTED: Highly capable young textile chemist and colorist desires responsible position in dyestuff manufacturers' laboratory or mill. 7 years' laboratory and mill experience, including being in charge of one of the largest dyehouse laboratories in the East. Expert color matcher. Write Box No. 942.

WANTED: Large manufacturer of synthetic resins has excellent opportunity for technical salesman under 35 with minimum of BS in Chemistry (or equivalent). Prefer someone with sales experience in the textile, plywood, or foundry resin field. Permanent position open in Florida-Georgia territory. Write Box No. 943.

POSITION WANTED: An individual with an exceptional combination of plant, laboratory experience, desires technical-executive position with dyestuff, fiber manufacturer, or textile chemical firm. Textile college graduate. Experience includes Dyer, Finisher, Laboratory Director, Manager. Write Box No. 932.

WANTED: RESEARCH CHEMIST. PhD, for research in organic chemistry involving the study of color fastness of dyed fabrics and the development of new dyeing processes. Permanent position in Celanese's growing research laboratories. Please send resumes to — Mr. J. A. Berg, CELANESE CORPORATION OF AMERICA, Morris Court, Summit, New Jersey.

POSITION WANTED: PRINT SUPERVISOR-COLORIST. Extensive experience on MACHINE and SCREEN printing of cottons, rayons and synthetics. Proven ability taking charge of printing and color-shop departments. Age 42. Write Box No. 945.

Classified Advertisements

POSITION WANTED: Supervisor of dyeing and finishing circular knit goods, tricot, piece goods and narrow fabrics. Desires position in sales with progressive organization serving the textile industry. Graduate L. T. I., B. T. C. degree. Write Box No. 946.

POSITION WANTED: Graduate L. T. I., B. T. C. degree, twenty years' experience as supervisor of dyeing and finishing all types of natural and synthetic fabrics. Desires position as supervisor of dyeing and finishing. Write Box No. 947.

HELP WANTED: Textile school graduate with 3 to 5 years' experience in shade matching and related work on synthetic fibers. Excellent opportunity for personal growth and advancement in progressive chemical company. Write Box No. 948.

WANTED: CHEMIST-DYER, experienced in dyeing and finishing rayon textiles. Trouble shooter. Thorough knowledge of chemistry. New England plant. Unusual opportunity for right man. Write complete details, experience, education, etc., to Box No. 949.

WANTED: DYESTUFF SALESMAN. Major manufacturer of dyestuff has an opening in the New England territory for a technical salesman. Desires man with knowledge of dyestuffs — some plant experience. Give complete details in first letter. Write Box No. 950.

WANTED: Dyer on synthetic knitted cloth and sweaters. Excellent opportunity for right man, with leading dyehouse in its field. Metropolitan Northern New Jersey area. Give detailed resume of experience. Salary open. Write Box No. 951.

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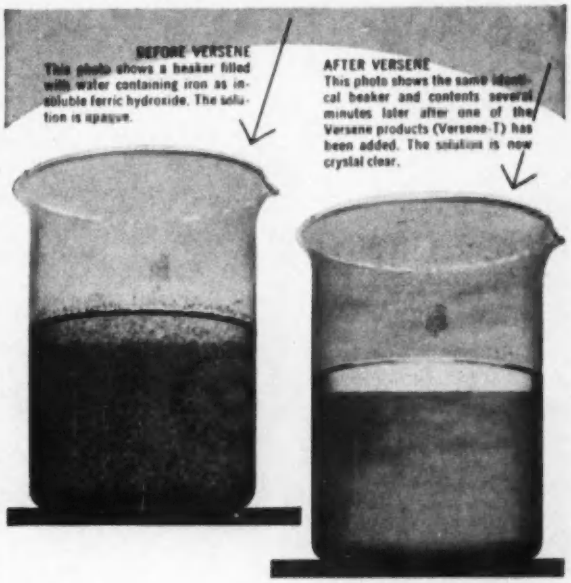
JIG DYER WANTED: Preferably with box experience. Applications will be kept confidential. Fair Lawn Finishing Company, Fair Lawn, New Jersey.


BEFORE VERSENE
This photo shows a beaker filled with water containing iron as insoluble ferric hydroxide. The solution is opaque.
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Conventionally yours...

Coming right before Convention time, conveniently in advance of the big AATCC meeting every year, is the annual Convention Issue of *American Dyestuff Reporter*. This year's Convention Issue will be dated August 29, and will give AATCC members and other members of the industry a pre-Convention run-down, including: Convention program details; abstracts of Convention papers; committee personnel and photographs; details on meetings, lunches, banquet; Exhibition floor plan and exhibitors' display descriptions, etc.

Manufacturers of textile chemicals, dyestuffs, textile chemical specialties and auxiliaries, wet-processing equipment and control instruments, and other wet-processing materials, will naturally find this Convention Issue of *American Dyestuff Reporter* the *best* place to advertise their products or services to the thousands of AATCC members attending the Convention and Exhibition.

Send for literature about this special AATCC Convention Issue. Find out the advantages and the features; *be there* when the AATCC Conventioneers look for your message. Write, wire or call Advertising Manager,

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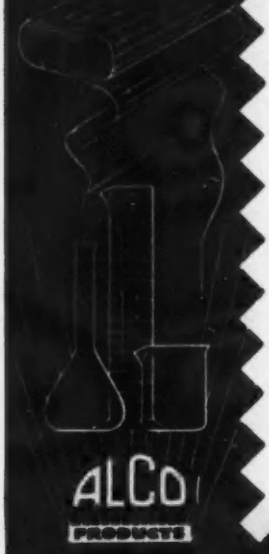

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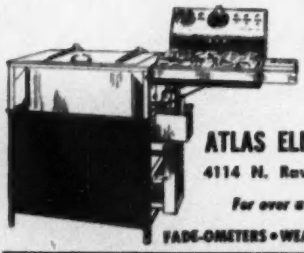

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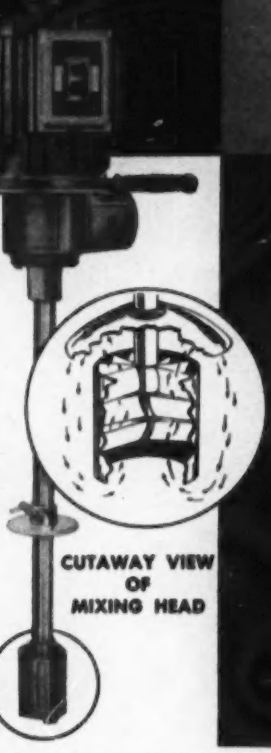

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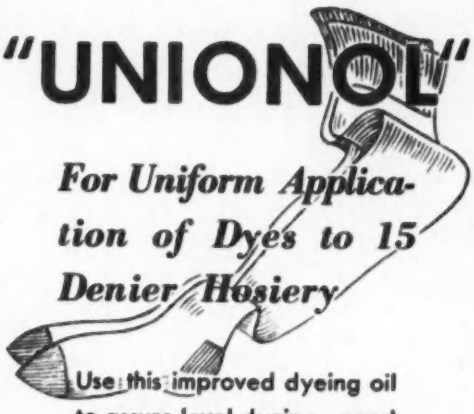

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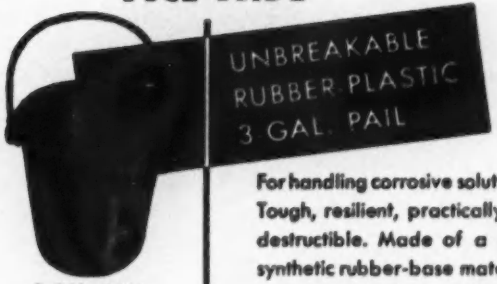

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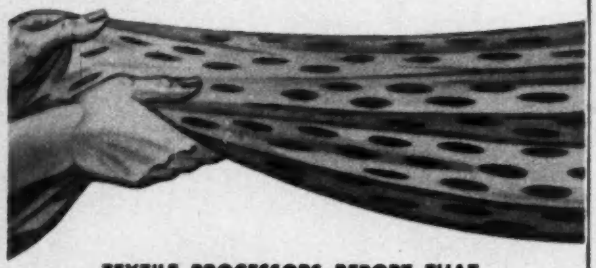

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working properties
. . . get all three with these vat navies

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